This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

## Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

## About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Stanford University Libraries
3 6105 000 940 820

LIBRARY OF THE
Leland Stanford Junior University

NOT TO BE TAKEN OUT OF THE LIBRARY

① 31246 97

# THE OBSERVATORY,

A

## MONTHLY REVIEW OF ASTRONOMY.

EDITED BY

H. H. TURNER, M.A., B.Sc., Sec. R.A.S.,
SAVILIAN PROFESSOR,
T. LEWIS, F.R.A.S.,
H. P. HOLLIS, B.A., F.R.A.S.

---

VOL. XVIII.

---

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.
1895.

LELAND STANFORD JUNIOR
LIBRARY
UNIVERSITY.

A 22745

ALERE FLAMMAM.

PRINTED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET.

# ANNUAL COMPANION

TO

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

No. 222. 1895. Vol. XVIII.

## INTRODUCTION.

The present 'Companion' closely resembles that of last year.

As in former years, we have to thank Mr. Denning for revising the "Meteor Notes," and Mr. Maw for kindly supplying a number of observations of Double Stars. We are indebted to Mr. Crommelin for the list of stars to be occulted on March 10.

M. Loewy has again favoured us with advance-proofs from which we have obtained the Variable Star Ephemerides. The occultations and phenomena of Jupiter's Satellites are from the 'Nautical Almanac'; the diagrams and Ephemerides of the Satellites of the other planets from the 'American Ephemeris.' The Ephemeris of Jupiter's 5th satellite is taken from Ast. Nach. No. 3253 and was computed by Mr. Marth from observations made by Prof. Barnard in 1893.

The "Fraction of the Year" is the fraction which has elapsed at mean noon of the particular day from mean noon on January 1. The Moon's declination is given for mean midnight. The "Longitude of the Moon's Terminator" is given for mean midnight; the letters M. and E. signifying morning and evening—that is, that the Sun is rising or setting on that particular longitude of the Moon's surface; the sign + indicates longitudes reckoned from the central meridian in a westward direction. The angles of disappearance and reappearance for occultations are reckoned from the *true* north in the direction N. E. S. W., as for double stars.

Greenwich Mean Time is used in all cases, and the astronomical day is reckoned from noon to noon as in previous years.

| Date. | Day of Year. | Fr. of Year. | Sun |  | ☉'s Dec. Noon. | M.T. at Apparent Noon. | Sid. T. at Mean Noon. | Moon's Phases. |
|---|---|---|---|---|---|---|---|---|
|  |  |  | Sets. | Rises. |  |  |  |  |
|  |  |  | h m | h m | ° ′ | h m s | h m s | d h m |
| Jan. 6 | 6 | ·014 | 4 4 | 20 7 | 22 30 S | 0 6 3 | 19 3 15 | ☽ 3 19 52 |
| 13 | 13 | ·033 | 4 14 | 20 3 | 21 29 | 8 54 | 19 30 51 | ○ 10 18 50 |
| 20 | 20 | ·052 | 4 25 | 19 56 | 20 7 | 11 14 | 19 58 27 | ☾ 17 10 55 |
| 27 | 27 | ·071 | 4 38 | 19 47 | 18 27 | 12 58 | 20 26 3 | ● 25 9 26 |
| Feb. 3 | 34 | ·090 | 4 50 | 19 36 | 16 30 | 14 2 | 20 53 39 | ☽ 2 12 16 |
| 10 | 41 | ·110 | 5 3 | 19 24 | 14 20 | 14 26 | 21 21 15 | ○ 9 5 23 |
| 17 | 48 | ·129 | 5 16 | 19 11 | 11 58 | 14 12 | 21 48 51 | ☾ 16 1 9 |
| 24 | 55 | ·148 | 5 28 | 18 56 | 9 27 | 13 24 | 22 16 27 | ● 24 4 44 |
| Mar. 3 | 62 | ·167 | 5 41 | 18 41 | 6 48 | 12 7 | 22 44 2 | ☽ 4 0 40 |
| 10 | 69 | ·186 | 5 53 | 18 26 | 4 5 | 10 26 | 23 11 38 | ○ 10 15 38 |
| 17 | 76 | ·205 | 6 5 | 18 10 | 1 20 S | 8 29 | 23 39 14 | ☾ 17 17 32 |
| 24 | 83 | ·225 | 6 17 | 17 54 | 1 26 N | 6 23 | 0 6 50 | ● 25 22 25 |
| 31 | 90 | ·244 | 6 29 | 17 38 | 4 10 | 4 15 | 0 34 26 |  |
| April 7 | 97 | ·263 | 6 40 | 17 22 | 6 50 | 2 11 | 1 2 2 | ☽ 2 9 28 |
| 14 | 104 | ·282 | 6 52 | 17 7 | 9 25 | 0 17 | 1 29 38 | ○ 9 1 43 |
| 21 | 111 | ·301 | 7 3 | 16 52 | 11 52 | 23 58 40 | 1 57 14 | ☾ 16 11 22 |
| 28 | 118 | ·320 | 7 15 | 16 38 | 14 10 | 57 24 | 2 24 49 | ● 24 13 11 |
| May 5 | 125 | ·340 | 7 26 | 16 25 | 16 16 | 56 34 | 2 52 25 | ☽ 1 15 44 |
| 12 | 132 | ·359 | 7 37 | 16 13 | 18 9 | 56 10 | 3 20 1 | ○ 8 11 59 |
| 19 | 139 | ·378 | 7 48 | 16 3 | 19 47 | 56 15 | 3 47 37 | ☾ 16 5 44 |
| 26 | 146 | ·397 | 7 57 | 15 55 | 21 8 | 56 47 | 4 15 13 | ● 24 0 46 |
|  |  |  |  |  |  |  |  | ☽ 30 20 49 |
| June 2 | 153 | ·416 | 8 5 | 15 49 | 22 12 | 57 42 | 4 42 49 | ○ 6 23 0 |
| 9 | 160 | ·435 | 8 12 | 15 45 | 22 57 | 23 58 56 | 5 10 25 | ☾ 14 23 28 |
| 16 | 167 | ·455 | 8 16 | 15 44 | 23 22 | 0 0 22 | 5 38 1 | ● 22 9 51 |
| 23 | 174 | ·474 | 8 19 | 15 45 | 23 27 | 1 53 | 6 5 37 | ☽ 29 2 1 |
| 30 | 181 | ·493 | 8 18 | 15 49 | 23 11 | 3 21 | 6 33 13 |  |
| July 7 | 188 | ·512 | 8 16 | 15 54 | 22 36 | 4 37 | 7 0 48 | ○ 6 11 29 |
| 14 | 195 | ·531 | 8 10 | 16 2 | 21 42 | 5 35 | 7 28 24 | ☾ 14 15 31 |
| 21 | 202 | ·550 | 8 3 | 16 11 | 20 29 | 6 10 | 7 56 0 | ● 21 17 32 |
| 28 | 209 | ·569 | 7 53 | 16 4 | 19 0 | 6 17 | 8 23 36 | ☽ 28 8 36 |
| Aug. 4 | 216 | ·589 | 7 42 | 16 31 | 17 15 | 5 55 | 8 51 12 | ○ 5 1 51 |
| 11 | 223 | ·608 | 7 30 | 16 42 | 15 17 | 5 2 | 9 18 48 | ☾ 13 5 19 |
| 18 | 230 | ·627 | 7 16 | 16 53 | 13 7 | 3 43 | 9 46 24 | ● 20 0 56 |
| 25 | 237 | ·646 | 7 1 | 17 4 | 10 46 | 0 2 0 | 10 14 0 | ☽ 26 17 43 |
| Sept. 1 | 244 | ·665 | 6 46 | 17 15 | 8 17 | 23 59 57 | 10 41 36 | ○ 3 17 55 |
| 8 | 251 | ·685 | 6 30 | 17 26 | 5 42 | 57 38 | 11 9 12 | ☾ 11 16 51 |
| 15 | 258 | ·704 | 6 14 | 17 38 | 3 2 | 55 12 | 11 36 47 | ● 18 8 55 |
| 22 | 265 | ·723 | 5 58 | 17 49 | 0 19 N | 52 44 | 12 4 23 | ☽ 25 6 23 |
| 29 | 272 | ·742 | 5 42 | 18 0 | 2 25 S | 50 22 | 12 31 59 |  |
| Oct. 6 | 279 | ·761 | 5 26 | 18 12 | 5 8 | 48 10 | 12 59 35 | ○ 3 10 47 |
| 13 | 286 | ·780 | 5 11 | 18 24 | 7 47 | 46 19 | 13 27 11 | ☾ 11 2 34 |
| 20 | 293 | ·800 | 4 56 | 18 36 | 10 22 | 44 53 | 13 54 47 | ● 17 18 10 |
| 27 | 300 | ·819 | 4 42 | 18 48 | 12 48 | 43 59 | 14 22 23 | ☽ 24 23 4 |
| Nov. 3 | 307 | ·838 | 4 29 | 19 0 | 15 5 | 43 40 | 14 49 59 | ○ 2 3 18 |
| 10 | 314 | ·857 | 4 17 | 19 13 | 17 10 | 44 1 | 15 17 34 | ☾ 9 11 7 |
| 17 | 321 | ·876 | 4 7 | 19 25 | 19 1 | 45 5 | 15 45 10 | ● 16 5 12 |
| 24 | 328 | ·895 | 3 59 | 19 37 | 20 34 | 46 49 | 16 12 46 | ☽ 23 19 19 |
| Dec. 1 | 335 | ·915 | 3 53 | 19 47 | 21 50 | 49 10 | 16 40 22 | ○ 1 18 38 |
| 8 | 342 | ·934 | 3 49 | 19 56 | 22 44 | 52 1 | 17 7 58 | ☾ 8 19 9 |
| 15 | 349 | ·953 | 3 49 | 20 2 | 23 17 | 55 17 | 17 35 34 | ● 15 18 30 |
| 22 | 356 | ·972 | 3 51 | 20 7 | 23 27 | 23 58 45 | 18 3 10 | ☽ 23 17 21 |
| 29 | 363 | ·991 | 3 56 | 20 9 | 23 14 S | 0 2 13 | 18 30 46 | ○ 31 8 31 |

*For Moon's phases:* ● signifies New; ☽ First Quarter; ○ Full; ☾ Last Quarter.

| JANUARY. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Termi-nator. |
| | | h m | h m | ° ′ | ° |
| 1 | Tu | 9 41 | 4 10 | 6 27 S | +21·3 M. |
| 2 | W | 10 51 | 4 50 | 0 45 S | + 9·1 M. |
| 3 | Th | 12 2 | 5 29 | 5 3 N | − 3·0 M. |
| 4 | F | 13 18 | 6 11 | 10 49 | −15·1 M. |
| 5 | S | 14 37 | 6 56 | 16 19 | −27·3 M. |
| 6 | **S** | 16 1 | 7 45 | 21 15 | −39·4 M. |
| 7 | M | 17 27 | 8 40 | 25 13 | −51·6 M. |
| 8 | Tu | 18 48 | 9 41 | 27 46 | −63·7 M. |
| 9 | W | 19 55 | 10 46 | 28 27 | −75·9 M. |
| 10 | Th | rises | 11 53 | 27 4 | −88·1 M. |
| 11 | F | 4 15 | 12 57 | 23 40 | +79·8 E. |
| 12 | S | 5 52 | 13 57 | 18 39 | +67·6 E. |
| 13 | **S** | 7 28 | 14 52 | 12 32 | +55·4 E. |
| 14 | M | 8 58 | 15 42 | 5 50 N | +43·3 E. |
| 15 | Tu | 10 23 | 16 30 | 0 58 S | +31·1 E. |
| 16 | W | 11 48 | 17 17 | 7 32 | +18·9 E. |
| 17 | Th | 13 8 | 18 4 | 13 34 | + 6·8 E. |
| 18 | F | 14 30 | 18 52 | 18 50 | − 5·4 E. |
| 19 | S | 15 50 | 19 41 | 23 7 | −17·5 E. |
| 20 | **S** | 17 6 | 20 33 | 26 15 | −29·7 E. |
| 21 | M | 18 14 | 21 26 | 28 4 | −41·9 E. |
| 22 | Tu | 19 7 | 22 19 | 28 30 | −54·0 E. |
| 23 | W | 19 45 | 23 10 | 27 34 | −66·2 E. |
| 24 | Th | 20 13 | 23 59 | 25 23 | −78·3 E. |
| 25 | F | sets | ...... | 22 5 | +89·5 M. |
| 26 | S | 5 7 | 0 45 | 17 55 | +77·3 M. |
| 27 | **S** | 6 19 | 1 28 | 13 4 | +65·2 M. |
| 28 | M | 7 30 | 2 9 | 7 44 | +53·0 M. |
| 29 | Tu | 8 40 | 2 48 | 2 6 S | +40·9 M. |
| 30 | W | 9 52 | 3 28 | 3 40 N | +28·8 M. |

| FEBRUARY. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Termi-nator. |
| | | h m | h m | ° ′ | ° |
| 1 | F | 12 19 | 4 50 | 14 52 N | + 4·5 M. |
| 2 | S | 13 39 | 5 36 | 19 52 | − 7·8 M. |
| 3 | **S** | 15 1 | 6 27 | 24 4 | −20·0 M. |
| 4 | M | 16 24 | 7 23 | 27 6 | −32·1 M. |
| 5 | Tu | 17 36 | 8 24 | 28 32 | −44·3 M. |
| 6 | W | 18 33 | 9 29 | 28 4 | −56·5 M. |
| 7 | Th | 19 13 | 10 34 | 25 34 | −68·6 M. |
| 8 | F | 19 39 | 11 36 | 21 14 | −80·8 M. |
| 9 | S | rises | 12 34 | 15 27 | +87·1 E. |
| 10 | **S** | 6 23 | 13 28 | 8 46 | +75·0 E. |
| 11 | M | 7 54 | 14 19 | 1 42 N | +62·8 E. |
| 12 | Tu | 9 22 | 15 8 | 5 16 S | +50·6 E. |
| 13 | W | 10 48 | 15 56 | 11 46 | +38·5 E. |
| 14 | Th | 12 12 | 16 46 | 17 30 | +26·3 E. |
| 15 | F | 13 36 | 17 36 | 22 13 | +14·1 E. |
| 16 | S | 14 55 | 18 28 | 25 43 | + 2·0 E. |
| 17 | **S** | 16 7 | 19 21 | 27 54 | −10·2 E. |
| 18 | M | 17 5 | 20 14 | 28 39 | −22·4 E. |
| 19 | Tu | 17 46 | 21 6 | 28 2 | −34·6 E. |
| 20 | W | 18 19 | 21 56 | 26 7 | −46·8 E. |
| 21 | Th | 18 40 | 22 42 | 23 4 | −59·0 E. |
| 22 | F | 18 56 | 23 26 | 19 5 | −71·1 E. |
| 23 | S | sets | ...... | 14 21 | −83·3 E. |
| 24 | **S** | 5 19 | 0 8 | 9 5 | +84·5 M. |
| 25 | M | 6 30 | 0 48 | 3 27 S | +72·3 M. |
| 26 | Tu | 7 42 | 1 28 | 2 20 N | +60·1 M. |
| 27 | W | 8 53 | 2 8 | 8 7 | +48·0 M. |
| 28 | Th | 10 7 | 2 49 | 13 40 N | +35·8 M. |

| MARCH. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Termi-nator. |
| | | h m | h m | ° ′ | ° |
| 1 | F | 11 25 | 3 33 | 18 46 N | +23·7 M. |
| 2 | S | 12 46 | 4 21 | 23 8 | +11·5 M. |
| 3 | **S** | 14 7 | 5 14 | 26 27 | − 0·7 M. |
| 4 | M | 15 21 | 6 12 | 28 22 | −12·9 M. |
| 5 | Tu | 16 23 | 7 13 | 28 34 | −25·0 M. |
| 6 | W | 17 7 | 8 16 | 26 53 | −37·2 M. |
| 7 | Th | 17 39 | 9 17 | 23 22 | −49·4 M. |
| 8 | F | 18 0 | 10 16 | 18 16 | −61·6 M. |
| 9 | S | 18 16 | 11 11 | 12 0 | −73·7 M. |
| 10 | **S** | rises | 12 3 | 5 3 N | −85·9 M. |
| 11 | M | 6 47 | 12 54 | 2 7 S | +81·9 E. |
| 12 | Tu | 8 16 | 13 43 | 9 2 | +69·7 E. |
| 13 | W | 9 43 | 14 34 | 15 19 | +57·5 E. |
| 14 | Th | 11 11 | 15 25 | 20 37 | +45·4 E. |
| 15 | F | 12 35 | 16 18 | 24 43 | +33·2 E. |
| 16 | S | 13 53 | 17 13 | 27 24 | +21·0 E. |
| 17 | **S** | 14 59 | 18 7 | 28 38 | + 8·8 E. |
| 18 | M | 15 47 | 19 1 | 28 23 | − 3·4 E. |
| 19 | Tu | 16 22 | 19 51 | 26 48 | −15·6 E. |
| 20 | W | 16 46 | 20 39 | 24 2 | −27·7 E. |
| 21 | Th | 17 4 | 21 24 | 20 16 | −39·9 E. |
| 22 | F | 17 18 | 22 6 | 15 43 | −52·1 E. |
| 23 | S | 17 29 | 22 47 | 10 35 | −64·3 E. |
| 24 | **S** | 17 39 | 23 27 | 5 1 S | −76·4 E. |
| 25 | M | sets | ...... | 0 47 N | −88·6 E. |
| 26 | Tu | 6 42 | 0 7 | 6 39 | +79·2 M. |
| 27 | W | 7 56 | 0 48 | 12 20 | +67·0 M. |
| 28 | Th | 9 14 | 1 32 | 17 37 | +54·8 M. |
| 29 | F | 10 34 | 2 19 | 22 12 | +42·7 M. |
| 30 | S | 11 54 | 3 10 | 25 47 | +30·5 M. |

| APRIL. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Termi-nator. |
| | | h m | h m | ° ′ | ° |
| 1 | M | 14 15 | 5 5 | 28 39 N | + 6·1 M. |
| 2 | Tu | 15 5 | 6 6 | 27 30 | − 6·1 M. |
| 3 | W | 15 39 | 7 6 | 24 36 | −18·3 M. |
| 4 | Th | 16 1 | 8 4 | 20 9 | −30·4 M. |
| 5 | F | 16 20 | 8 59 | 14 28 | −42·6 M. |
| 6 | S | 16 35 | 9 50 | 7 55 | −54·8 M. |
| 7 | **S** | 16 47 | 10 40 | 0 57 N | −66·9 M. |
| 8 | M | 16 59 | 11 29 | 6 2 S | −79·1 M. |
| 9 | Tu | rises | 12 19 | 12 37 | +88·5 E. |
| 10 | W | 8 39 | 13 11 | 18 26 | +76·3 E. |
| 11 | Th | 10 7 | 14 4 | 23 7 | +64·2 E. |
| 12 | F | 11 30 | 15 0 | 26 27 | +52·0 E. |
| 13 | S | 12 43 | 15 56 | 28 16 | +39·8 E. |
| 14 | **S** | 13 40 | 16 51 | 28 32 | +27·7 E. |
| 15 | M | 14 21 | 17 44 | 27 22 | +15·5 E. |
| 16 | Tu | 14 49 | 18 33 | 24 55 | + 3·3 E. |
| 17 | W | 15 9 | 19 19 | 21 26 | − 9·0 E. |
| 18 | Th | 15 24 | 20 3 | 17 6 | −21·3 E. |
| 19 | F | 15 37 | 20 44 | 12 9 | −33·4 E. |
| 20 | S | 15 47 | 21 24 | 6 43 | −45·6 E. |
| 21 | **S** | 15 56 | 22 4 | 0 59 S | −57·8 E. |
| 22 | M | 16 7 | 22 45 | 4 53 N | −70·0 E. |
| 23 | Tu | 16 18 | 23 28 | 10 40 | −82·2 E. |
| 24 | W | sets | ...... | 16 8 | +85·5 M. |
| 25 | Th | 8 12 | 0 14 | 20 59 | +73·3 M. |
| 26 | F | 9 39 | 1 5 | 24 54 | +61·1 M. |
| 27 | S | 10 58 | 2 0 | 27 31 | +49·0 M. |
| 28 | **S** | 12 9 | 3 0 | 28 31 | +36·8 M. |
| 29 | M | 13 3 | 4 1 | 27 46 | +24·6 M. |
| 30 | Tu | 13 42 | 5 1 | 25 16 N | +12·4 M. |

| MAY. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Terminator. |
| | | h m | h m | ° ′ | ° |
| 1 | W | 14 9 | 5 59 | 21 13 N | + 0·2 M. |
| 2 | Th | 14 27 | 6 53 | 15 56 | −12·0 M. |
| 3 | F | 14 41 | 7 44 | 9 47 | −24·3 M. |
| 4 | S | 14 55 | 8 33 | 3 7 N | −36·5 M. |
| 5 | **S** | 15 7 | 9 21 | 3 41 S | −48·7 M. |
| 6 | M | 15 19 | 10 9 | 10 16 | −60·8 M. |
| 7 | Tu | 15 34 | 10 59 | 16 16 | −73·0 M. |
| 8 | W | rises | 11 51 | 21 22 | −85·3 M. |
| 9 | Th | 9 3 | 12 46 | 25 13 | +82·4 E. |
| 10 | F | 10 22 | 13 42 | 27 37 | +70·2 E. |
| 11 | S | 11 27 | 14 38 | 28 28 | +58·0 E. |
| 12 | **S** | 12 15 | 15 33 | 27 46 | +45·9 E. |
| 13 | M | 12 49 | 16 25 | 25 43 | +33·7 E. |
| 14 | Tu | 13 13 | 17 13 | 22 31 | +21·5 E. |
| 15 | W | 13 29 | 17 57 | 18 26 | + 9·3 E. |
| 16 | Th | 13 41 | 18 39 | 13 39 | − 3·0 E. |
| 17 | F | 13 54 | 19 19 | 8 23 | −15·3 E. |
| 18 | S | 14 4 | 19 59 | 2 47 S | −27·5 E. |
| 19 | **S** | 14 13 | 20 39 | 3 0 N | −39·7 E. |
| 20 | M | 14 24 | 21 21 | 8 47 | −51·9 E. |
| 21 | Tu | 14 35 | 22 6 | 14 21 | −64·2 E. |
| 22 | W | 14 53 | 22 56 | 19 26 | −76·4 E. |
| 23 | Th | 15 16 | 23 50 | 23 43 | −88·6 E. |
| 24 | F | sets | …… | 26 47 | +79·2 M. |
| 25 | S | 9 56 | 0 49 | 28 17 | +67·0 M. |
| 26 | **S** | 10 57 | 1 52 | 27 59 | +54·8 M. |
| 27 | M | 11 42 | 2 54 | 25 51 | +42·6 M. |
| 28 | Tu | 12 11 | 3 54 | 22 4 | +30·3 M. |
| 29 | W | 12 33 | 4 49 | 16 59 | +18·1 M. |
| 30 | Th | 12 49 | 5 41 | 11 1 | + 5·9 M. |

| JUNE. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Terminator. |
| | | h m | h m | ° ′ | ° |
| 1 | S | 13 14 | 7 18 | 2 9 S | −18·5 M. |
| 2 | **S** | 13 26 | 8 4 | 8 39 | −30·7 M. |
| 3 | M | 13 40 | 8 52 | 14 41 | −42·9 M. |
| 4 | Tu | 13 57 | 9 43 | 19 56 | −55·0 M. |
| 5 | W | 14 21 | 10 35 | 24 6 | −67·2 M. |
| 6 | Th | 14 53 | 11 30 | 26 56 | −79·4 M. |
| 7 | F | rises | 12 27 | 28 16 | +88·1 E. |
| 8 | S | 10 7 | 13 22 | 28 3 | +75·9 E. |
| 9 | **S** | 10 47 | 14 16 | 26 24 | +63·7 E. |
| 10 | M | 11 14 | 15 5 | 23 31 | +51·5 E. |
| 11 | Tu | 11 33 | 15 51 | 19 39 | +39·3 E. |
| 12 | W | 11 48 | 16 34 | 15 3 | +27·1 E. |
| 13 | Th | 12 0 | 17 15 | 9 56 | +14·9 E. |
| 14 | F | 12 10 | 17 54 | 4 27 S | + 2·6 E. |
| 15 | S | 12 19 | 18 34 | 1 13 N | − 9·6 E. |
| 16 | **S** | 12 30 | 19 14 | 6 56 | −21·8 E. |
| 17 | M | 12 42 | 19 58 | 12 31 | −34·0 E. |
| 18 | Tu | 12 56 | 20 45 | 17 44 | −46·2 E. |
| 19 | W | 13 16 | 21 37 | 22 18 | −58·4 E. |
| 20 | Th | 13 45 | 22 34 | 25 50 | −70·6 E. |
| 21 | F | 14 29 | 23 36 | 27 56 | −82·8 E. |
| 22 | S | sets | …… | 28 15 | +84·8 M. |
| 23 | **S** | 9 38 | 0 40 | 26 39 | +72·6 M. |
| 24 | M | 10 12 | 1 43 | 23 14 | +60·4 M. |
| 25 | Tu | 10 37 | 2 42 | 18 20 | +48·2 M. |
| 26 | W | 10 54 | 3 36 | 12 23 | +36·0 M. |
| 27 | Th | 11 8 | 4 27 | 5 51 N | +23·8 M. |
| 28 | F | 11 21 | 5 16 | 0 52 S | +11·6 M. |
| 29 | S | 11 34 | 6 3 | 7 27 | − 0·7 M. |
| 30 | **S** | 11 47 | 6 50 | 13 33 S | −13·0 M. |

| JULY. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Terminator. |
| | | h m | h m | ° ′ | ° |
| 1 | M | 12 3 | 7 39 | 18 56 S | −25·2 M. |
| 2 | Tu | 12 24 | 8 30 | 23 17 | −37·4 M. |
| 3 | W | 12 52 | 9 24 | 26 24 | −49·6 M. |
| 4 | Th | 13 34 | 10 19 | 28 5 | −61·8 M. |
| 5 | F | 14 28 | 11 14 | 28 15 | −74·0 M. |
| 6 | S | rises | 12 8 | 26 59 | −86·3 M. |
| 7 | **S** | 9 17 | 12 59 | 24 25 | +81·5 E. |
| 8 | M | 9 38 | 13 46 | 20 48 | +69·3 E. |
| 9 | Tu | 9 53 | 14 30 | 16 22 | +57·1 E. |
| 10 | W | 10 8 | 15 12 | 11 21 | +49·9 E. |
| 11 | Th | 10 17 | 15 51 | 5 58 | +32·7 E. |
| 12 | F | 10 26 | 16 30 | 0 21 S | +20·4 E. |
| 13 | S | 10 37 | 17 10 | 5 19 N | + 8·1 E. |
| 14 | **S** | 10 47 | 17 51 | 10 52 | − 4·0 E. |
| 15 | M | 10 59 | 18 35 | 16 8 | −16·3 E. |
| 16 | Tu | 11 16 | 19 24 | 20 52 | −28·5 E. |
| 17 | W | 11 40 | 20 18 | 24 44 | −40·7 E. |
| 18 | Th | 12 17 | 21 17 | 27 23 | −53·0 E. |
| 19 | F | 13 9 | 22 20 | 28 25 | −65·2 E. |
| 20 | S | 14 22 | 23 24 | 27 34 | −77·4 E. |
| 21 | **S** | sets | …… | 24 47 | −89·7 E. |
| 22 | M | 8 38 | 0 26 | 20 17 | +78·2 M. |
| 23 | Tu | 8 59 | 1 25 | 14 28 | +65·9 M. |
| 24 | W | 9 14 | 2 19 | 7 52 | +53·7 M. |
| 25 | Th | 9 27 | 3 10 | 0 56 N | +41·5 M. |
| 26 | F | 9 40 | 3 58 | 5 55 S | +29·3 M. |
| 27 | S | 9 54 | 4 47 | 12 19 | +17·0 M. |
| 28 | **S** | 10 9 | 5 36 | 17 57 | + 4·8 M. |
| 29 | M | 10 28 | 6 27 | 22 34 | − 7·4 M. |
| 30 | Tu | 10 54 | 7 20 | 25 58 | −19·6 M. |

| AUGUST. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Terminator. |
| | | h m | h m | ° ′ | ° |
| 1 | Th | 12 21 | 9 9 | 28 27 S | −44·0 M. |
| 2 | F | 13 24 | 10 3 | 27 30 | −56·3 M. |
| 3 | S | 14 37 | 10 55 | 25 14 | −68·5 M. |
| 4 | **S** | 15 51 | 11 43 | 21 51 | −80·7 M. |
| 5 | M | rises | 12 28 | 17 36 | +87·1 E. |
| 6 | Tu | 8 15 | 13 10 | 12 42 | +74·9 E. |
| 7 | W | 8 26 | 13 50 | 7 22 | +62·7 E. |
| 8 | Th | 8 35 | 14 29 | 1 47 S | +50·5 E. |
| 9 | F | 8 44 | 15 8 | 3 52 N | +38·3 E. |
| 10 | S | 8 55 | 15 48 | 9 26 | +26·0 E. |
| 11 | **S** | 9 6 | 16 30 | 14 44 | +13·8 E. |
| 12 | M | 9 21 | 17 16 | 19 34 | + 1·6 E. |
| 13 | Tu | 9 41 | 18 6 | 23 40 | −10·7 E. |
| 14 | W | 10 10 | 19 2 | 26 42 | −22·9 E. |
| 15 | Th | 10 53 | 20 1 | 28 20 | −35·1 E. |
| 16 | F | 11 56 | 21 4 | 28 15 | −47·3 E. |
| 17 | S | 13 15 | 22 7 | 26 17 | −59·5 E. |
| 18 | **S** | 14 49 | 23 7 | 22 29 | −71·7 E. |
| 19 | M | 16 24 | …… | 17 9 | −83·9 E. |
| 20 | Tu | sets | 0 3 | 10 42 | +83·8 M. |
| 21 | W | 7 33 | 0 57 | 3 40 N | +71·6 M. |
| 22 | Th | 7 47 | 1 48 | 3 30 S | +59·4 M. |
| 23 | F | 8 0 | 2 38 | 10 19 | +47·2 M. |
| 24 | S | 8 14 | 3 29 | 16 26 | +35·0 M. |
| 25 | **S** | 8 31 | 4 21 | 21 31 | +22·8 M. |
| 26 | M | 8 56 | 5 14 | 25 20 | +10·6 M. |
| 27 | Tu | 9 30 | 6 9 | 27 42 | − 1·6 M. |
| 28 | W | 10 15 | 7 5 | 28 33 | −13·8 M. |
| 29 | Th | 11 14 | 7 59 | 27 55 | −26·0 M. |
| 30 | F | 12 25 | 8 51 | 25 56 | −38·2 M. |

| SEPTEMBER. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Termi-nator. |
| | | h m | h m | ° ′ | ° |
| 1 | **S** | 14 54 | 10 26 | 18 45 S | −62·7 M. |
| 2 | M | 16 6 | 11 9 | 14 0 | −74·9 M. |
| 3 | Tu | 17 17 | 11 50 | 8 45 | −87·1 M. |
| 4 | W | rises | 12 29 | 3 12 S | +80·7 E. |
| 5 | Th | 6 54 | 13 8 | 2 28 N | +68·5 E. |
| 6 | F | 7 3 | 13 47 | 8 6 | +56·3 E. |
| 7 | S | 7 14 | 14 29 | 13 29 | +44·1 E. |
| 8 | **S** | 7 27 | 15 13 | 18 25 | +31·9 E. |
| 9 | M | 7 45 | 16 1 | 22 41 | +19·7 E. |
| 10 | Tu | 8 10 | 16 53 | 25 59 | + 7·5 E. |
| 11 | W | 8 45 | 17 49 | 28 1 | − 4·7 E. |
| 12 | Th | 9 39 | 18 49 | 28 31 | −16·9 E. |
| 13 | F | 10 50 | 19 50 | 27 16 | −29·1 E. |
| 14 | S | 12 14 | 20 49 | 24 16 | −41·3 E. |
| 15 | **S** | 13 48 | 21 46 | 19 39 | −53·5 E. |
| 16 | M | 15 22 | 22 41 | 13 44 | −65·7 E. |
| 17 | Tu | 16 55 | 23 33 | 6 56 N | −78·0 E. |
| 18 | W | sets | …… | 0 17 S | +89·8 M. |
| 19 | Th | 6 5 | 0 24 | 7 26 | +77·6 M. |
| 20 | F | 6 17 | 1 16 | 14 3 | +65·4 M. |
| 21 | S | 6 35 | 2 8 | 19 44 | +53·2 M. |
| 22 | **S** | 6 58 | 3 3 | 24 9 | +41·0 M. |
| 23 | M | 7 27 | 3 59 | 27 6 | +28·8 M. |
| 24 | Tu | 8 9 | 4 56 | 28 26 | +16·6 M. |
| 25 | W | 9 6 | 5 53 | 28 12 | + 4·5 M. |
| 26 | Th | 10 13 | 6 46 | 26 33 | − 7·6 M. |
| 27 | F | 11 26 | 7 37 | 23 42 | −19·8 M. |
| 28 | S | 12 42 | 8 24 | 19 51 | −32·0 M. |
| | **S** | 13 55 | 9 8 | 15 16 | −44·2 M. |
| | M | 15 7 | 9 49 | 10 9 S | −56·4 M. |

| OCTOBER. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Termi-nator. |
| | | h m | h m | ° ′ | ° |
| 1 | Tu | 16 16 | 10 28 | 4 40 S | −68·7 M. |
| 2 | W | 17 27 | 11 7 | 1 0 N | −80·9 M. |
| 3 | Th | rises. | 11 47 | 6 40 | +86·9 E. |
| 4 | F | 5 24 | 12 28 | 12 9 | +74·7 E. |
| 5 | S | 5 36 | 13 11 | 17 15 | + ·5 E. |
| 6 | **S** | 5 52 | 13 58 | 21 42 | +50·3 E. |
| 7 | M | 6 15 | 14 49 | 25 14 | +38·1 E. |
| 8 | Tu | 6 46 | 15 44 | 27 34 | +25·9 E. |
| 9 | W | 7 32 | 16 41 | 28 27 | +13·7 E. |
| 10 | Th | 8 36 | 17 40 | 27 42 | + 1·6 E. |
| 11 | F | 9 54 | 18 38 | 25 17 | −10·6 E. |
| 12 | S | 11 21 | 19 34 | 21 19 | −22·8 E. |
| 13 | **S** | 12 50 | 20 28 | 16 1 | −35·0 E. |
| 14 | M | 14 22 | 21 19 | 9 44 | −47·2 E. |
| 15 | Tu | 15 50 | 22 9 | 2 50 N | −59·4 E. |
| 16 | W | 17 20 | 23 0 | 4 16 S | −71·6 E. |
| 17 | Th | 18 52 | 23 52 | 11 7 | −83·8 E. |
| 18 | F | sets | …… | 17 17 | +84·1 M. |
| 19 | S | 4 58 | 0 47 | 22 21 | +71·9 M. |
| 20 | **S** | 5 24 | 1 44 | 25 59 | +59·7 M. |
| 21 | M | 6 2 | 2 42 | 27 59 | +47·5 M. |
| 22 | Tu | 6 53 | 3 41 | 28 19 | +35·3 M. |
| 23 | W | 7 59 | 4 37 | 27 5 | +23·1 M. |
| 24 | Th | 9 12 | 5 30 | 24 32 | +10·9 M. |
| 25 | F | 10 27 | 6 19 | 20 56 | − 1·2 M. |
| 26 | S | 11 41 | 7 4 | 16 32 | −13·4 M. |
| 27 | **S** | 12 53 | 7 46 | 11 33 | −25·6 M. |
| 28 | M | 14 3 | 8 26 | 6 11 | −37·8 M. |
| 29 | Tu | 15 13 | 9 5 | 0 35 S | −50·0 M. |
| 30 | W | 16 23 | 9 45 | 5 5 N | −62·1 M. |

| NOVEMBER. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Termi-nator. |
| | | h m | h m | ° ′ | ° |
| 1 | F | 18 51 | 11 8 | 15 52 N | −86·4 M. |
| 2 | S | rises | 11 54 | 20 32 | +81·5 E. |
| 3 | **S** | 4 20 | 12 45 | 24 21 | +69·3 E. |
| 4 | M | 4 48 | 13 39 | 27 0 | +57·1 E. |
| 5 | Tu | 5 31 | 14 36 | 28 13 | +45·0 E. |
| 6 | W | 6 30 | 15 35 | 27 49 | +32·8 E. |
| 7 | Th | 7 43 | 16 33 | 25 47 | +20·6 E. |
| 8 | F | 9 6 | 17 29 | 22 12 | + 8·4 E. |
| 9 | S | 10 33 | 18 21 | 17 21 | − 3·7 E |
| 10 | **S** | 12 1 | 19 12 | 11 30 | −15·9 E. |
| 11 | M | 13 27 | 20 0 | 5 0 N | −28·1 E. |
| 12 | Tu | 14 53 | 20 49 | 1 49 S | −40·3 E. |
| 13 | W | 16 21 | 21 39 | 8 34 | −52·5 E. |
| 14 | Th | 17 50 | 22 31 | 14 53 | −64·7 E. |
| 15 | F | 19 22 | 23 27 | 20 20 | −76·9 E. |
| 16 | S | sets | …… | 24 33 | −89·1 E. |
| 17 | **S** | 3 55 | 0 25 | 27 13 | +78·9 M. |
| 18 | M | 4 40 | 1 24 | 28 12 | +66·7 M. |
| 19 | Tu | 5 40 | 2 23 | 27 31 | +54·5 M. |
| 20 | W | 6 53 | 3 19 | 25 23 | +42·3 M. |
| 21 | Th | 8 7 | 4 10 | 22 3 | +30·2 M. |
| 22 | F | 9 25 | 4 58 | 17 51 | +18·0 M. |
| 23 | S | 10 38 | 5 41 | 13 0 | + 5·8 M. |
| 24 | **S** | 11 48 | 6 22 | 7 44 | − 6·3 M. |
| 25 | M | 12 59 | 7 2 | 2 13 S | −18·5 M. |
| 26 | Tu | 14 7 | 7 41 | 3 24 N | −30·7 M. |
| 27 | W | 15 18 | 8 20 | 8 57 | −42·9 M. |
| 28 | Th | 16 32 | 9 2 | 14 16 | −55·0 M. |
| 29 | F | 17 50 | 9 47 | 19 7 | −67·2 M. |
| 30 | S | 19 8 | 10 36 | 23 14 N | −79·4 M. |

| DECEMBER. | | | | | |
|---|---|---|---|---|---|
| Day. | | Moon. | | | |
| Month. | Week. | Sets. | Souths. | Dec. | Long. of Termi-nator. |
| | | h m | h m | ° ′ | ° |
| 1 | **S** | 20 26 | 11 30 | 26 17 N | +88·6 E. |
| 2 | M | rises | 12 28 | 27 55 | +76·4 E. |
| 3 | Tu | 4 21 | 13 27 | 27 56 | +64·2 E. |
| 4 | W | 5 31 | 14 27 | 26 14 | +52·1 E. |
| 5 | Th | 6 54 | 15 24 | 22 56 | +39·9 E. |
| 6 | F | 8 22 | 16 18 | 18 17 | +27·7 E. |
| 7 | S | 9 50 | 17 9 | 12 37 | +15·5 E. |
| 8 | **S** | 11 14 | 17 57 | 6 19 N | + 3·4 E. |
| 9 | M | 12 38 | 18 45 | 0 19 S | − 8·7 E. |
| 10 | Tu | 14 3 | 19 33 | 6 55 | −20·9 E. |
| 11 | W | 15 29 | 20 23 | 13 11 | −33·1 E. |
| 12 | Th | 16 55 | 21 15 | 18 45 | −45·2 E. |
| 13 | F | 18 24 | 22 11 | 23 16 | −57·4 E. |
| 14 | S | 19 44 | 23 9 | 26 25 | −69·6 E. |
| 15 | **S** | sets | …… | 27 58 | −81·7 E. |
| 16 | M | 3 23 | 0 8 | 27 52 | +86·2 M. |
| 17 | Tu | 4 31 | 1 5 | 26 12 | +74·0 M. |
| 18 | W | 5 47 | 1 59 | 23 13 | +61·8 M. |
| 19 | Th | 7 4 | 2 49 | 19 14 | +49·7 M. |
| 20 | F | 8 20 | 3 35 | 14 31 | +37·5 M. |
| 21 | S | 9 32 | 4 17 | 9 20 | +25·3 M. |
| 22 | **S** | 10 43 | 4 57 | 3 52 S | +13·1 M. |
| 23 | M | 11 52 | 5 36 | 1 42 N | + 1·0 M. |
| 24 | Tu | 13 1 | 6 15 | 7 15 | −11·1 M. |
| 25 | W | 14 11 | 6 55 | 12 36 | −23·3 M. |
| 26 | Th | 15 26 | 7 39 | 17 34 | −35·5 M. |
| 27 | F | 16 45 | 8 25 | 21 55 | −47·6 M. |
| 28 | S | 18 4 | 9 17 | 25 21 | −59·8 M. |
| 29 | **S** | 19 17 | 10 13 | 27 32 | −72·0 M. |
| 30 | M | 20 18 | 11 13 | 28 8 | −84·1 M. |

## *List of the principal Meteor-showers of the Year, derived from recent Observations.* By W. F. Denning.

| Date. | Radiant. | | Meteors. | Date. | Radiant. | | Meteors. |
|---|---|---|---|---|---|---|---|
| | α<br>° | δ<br>° | | | α<br>° | δ<br>° | |
| Jan. 2 ... | **230** | **+53** | Swift; long paths. | July 28 ... | **339** | **−12** | Slow; long. |
| 3 ... | 156 | +41 | Swift. | 30 ... | 6 | +35 | Swift; streaks. |
| 11 ... | 220 | +13 | Swift; streaks. | Aug. 4 ... | 30 | +36 | Swift; streaks. |
| 17 ... | 295 | +53 | Slow; bright. | 10 ... | **45** | **+57** | Swift; streaks. |
| 22 ... | 208 | − 8 | Very swift; streaks. | 14 ... | 311 | +62 | Rather swift. |
| 25 ... | 131 | +32 | Swift. | 15 ... | 292 | +53 | Swift; bright. |
| 29 ... | 213 | +52 | Very swift. | 16 ... | 61 | +48 | Swift; streaks. |
| Feb. 1 ... | 211 | +69 | Slow; short. | 21 ... | 73 | +41 | Swift; streaks. |
| 15 ... | 236 | +11 | Swift; streaks. | 22 ... | 291 | +60 | Slow; bright. |
| 15 ... | 261 | + 4 | Swift; streaks. | 23 ... | 70 | +50 | Swift; streaks. |
| 20 ... | 181 | +34 | Swift; bright. | 25 ... | 5 | +11 | Slow; short. |
| 20 ... | 263 | +36 | Swift; streaks. | Sept. 4 ... | 346 | ± 0 | Slow. |
| Mar. 1 ... | 47 | +45 | Very slow. | 7 ... | 62 | +37 | Swift; streaks. |
| 4 ... | 175 | +10 | Slow; bright. | 15 ... | 48 | +44 | Very swift. |
| 18 ... | 316 | +76 | Slow; bright. | 21 ... | 31 | +19 | Slow. |
| 24 ... | 161 | +58 | Swift. | 22 ... | 335 | +58 | Slowish. |
| 27 ... | 229 | +32 | Swift; small. | 22 ... | 63 | +22 | Swift; streaks. |
| 28 ... | 263 | +62 | Rather swift. | 27 ... | 75 | +15 | Swift; streaks. |
| Apr. 17 ... | 165 | − 6 | Very slow. | Oct. 2 ... | 225 | +52 | Slow; bright. |
| 18 ... | 213 | +53 | Swift; short. | 4 ... | 133 | +79 | Swift; streaks. |
| 18 ... | 231 | +17 | Swift; short. | 4 ... | 310 | +77 | Slowish. |
| 19 ... | 218 | +33 | Slow; bright. | 8 ... | 77 | +31 | Swift; streaks. |
| 19 .. | 229 | − 2 | Slow; long. | 11 ... | 13 | + 6 | Slow; bright. |
| 20 ... | **270** | **+33** | Swift. | 14 ... | 40 | +20 | Rather swift. |
| 25 ... | 272 | +21 | Swift; short. | 14 ... | 135 | +68 | Swift; streaks. |
| May 1 ... | 239 | +46 | Small; short. | 18 ... | **92** | **+15** | Swift; streaks. |
| 5 ... | 254 | −21 | Slowish. | 20 ... | 106 | +12 | Swift; streaks. |
| 6 ... | **338** | **− 2** | Swift; streaks. | 29 ... | 109 | +23 | Very swift. |
| 7 ... | 244 | + 7 | Slow; bright. | Nov. 1 ... | 43 | +22 | Slow; bright. |
| 14 ... | 314 | +15 | Swift; streaks. | 2 ... | 55 | + 9 | Slow; bright. |
| 29 ... | 264 | +64 | Slowish. | 13 ... | **150** | **+22** | Swift; streaks. |
| 30 ... | 333 | +27 | Swift; streaks. | 16 ... | 154 | +41 | Swift; streaks. |
| June 7 ... | 247 | −25 | Slow; very bright. | 17 ... | 53 | +71 | Slowish. |
| 10 ... | 261 | + 5 | Very slow. | 20 ... | 62 | +23 | Slow; bright. |
| 13 ... | 310 | +61 | Swift; streaks. | 23-27 | **25** | **+44** | Very slow; trains. |
| 15 ... | 291 | +52 | Swift; small. | 30 ... | 190 | +58 | Swift; streaks. |
| 15 ... | 285 | +23 | Slowish. | Dec. 4 ... | 162 | +58 | Swift; streaks. |
| 20 ... | 335 | +57 | Swift. | 4 ... | 110 | +25 | Slowish. |
| 28 ... | 294 | +39 | Slow. | 6 ... | 80 | +23 | Slow; bright. |
| July 4 ... | 303 | +24 | Swift. | 8 ... | 145 | + 7 | Swift; streaks. |
| 11 ... | 349 | +53 | Swift. | 8 ... | 208 | +71 | Rather swift. |
| 19 ... | 314 | +48 | Swift; short. | 10 ... | **108** | **+33** | Swift; short. |
| 20 ... | 269 | +49 | Swift. | 12 ... | 119 | +29 | Rather swift. |
| 22 ... | 16 | +31 | Swift; streaks. | 22 ... | 194 | +67 | Swift; streaks. |
| 25 ... | 48 | +43 | Swift; streaks. | 24 ... | 218 | +36 | Swift; streaks. |

The radiant-points of the more brilliant showers are indicated by heavier type.

The Perseids, with max. on August 10, are visible for a considerable period and their radiant-point exhibits an easterly motion amongst the stars. The following is an ephemeris:—

| Date. | Radiant. | | Date. | Radiant. | | Date. | Radiant. | |
|---|---|---|---|---|---|---|---|---|
| | α<br>° | δ<br>° | | α<br>° | δ<br>° | | α<br>° | δ<br>° |
| July 19 ... | 19 | +51 | July 29 ... | 32 | +54 | Aug. 8 ... | 42 | +57 |
| 21 ... | 22 | +52 | 31 ... | 34 | +55 | 10 ... | 45 | +57 |
| 23 ... | 25 | +52 | Aug. 2 ... | 36 | +55 | 12 ... | 47 | +57 |
| 25 ... | 27 | +53 | 4 ... | 38 | +56 | 14 ... | 50 | +58 |
| 27 ... | 30 | +54 | 6 ... | 40 | +56 | 16 ... | 53 | +58 |

| | **Mercury (☿).** | | | | | | **Venus (♀).** | | | | | | **Mars (♂).** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1895. | R.A. Noon. | Dec. Noon. | Diam. | Rises. | Transits. | Sets. | R.A. Noon. | Dec. Noon. | Diam. | Rises. | Transits. | Sets. | R.A. Noon. | Dec. Noon. | Diam. | Rises. | Transits. | Sets. |
| | h m s | ° ′ | ″ | h m | h m | h m | h m s | ° ′ | ″ | h m | h m | h m | h m s | ° ′ | ″ | h m | h m | h m |
| Jan. 1.. | 18 25 23 | 24 43 S. | 4·6 | 20 2 | 23 45 | 3 28 | 19 20 51 | 23 10 S. | 9·8 | 20 42 | 0 37 | 4 32 | 1 51 49 | 12 38 N. | 12·6 | 23 58 | 7 7 | 14 16 |
| 11.. | 19 36 7 | 23 38 | 4·8 | 20 22 | 0 13 | 4 4 | 20 14 27 | 21 10 | 9·9 | 20 43 | 0 51 | 4 59 | 2 7 40 | 14 12 | 11·4 | 23 26 | 6 44 | 14 2 |
| 21... | 20 47 15 | 20 1 | 5·0 | 20 30 | 0 45 | 5 0 | 21 6 9 | 18 7 | 10·0 | 20 37 | 1 4 | 5 31 | 2 25 29 | 15 50 | 10·4 | 22 55 | 6 22 | 13 49 |
| 31... | 21 54 26 | 13 56 | 5·6 | 20 22 | 1 13 | 6 4 | 21 55 45 | 14 13 | 10·2 | 20 24 | 1 14 | 6 4 | 2 45 0 | 17 27 | 9·5 | 22 26 | 6 3 | 13 40 |
| Feb. 10... | 22 43 24 | 7 3 | 7·2 | 19 54 | 1 22 | 6 50 | 22 43 21 | 9 41 | 10·4 | 20 7 | 1 22 | 6 37 | 3 5 57 | 19 0 | 8·7 | 21 57 | 5 44 | 13 31 |
| 20... | 22 44 18 | 4 22 | 9·8 | 19 2 | 0 43 | 6 24 | 23 29 26 | 4 44 S. | 10·6 | 19 50 | 1 29 | 7 8 | 3 28 6 | 20 26 | 8·1 | 21 31 | 5 27 | 13 23 |
| Mar. 2 .. | 22 8 26 | 8 3 | 10·6 | 17 59 | 23 22 | 4 45 | 0 14 36 | 0 26 N. | 10·8 | 19 28 | 1 34 | 7 40 | 3 51 19 | 21 44 | 7·6 | 21 7 | 5 11 | 13 15 |
| 12... | 21 59 23 | 11 16 | 9·0 | 17 31 | 22 37 | 3 43 | 0 59 33 | 5 36 | 11·0 | 19 8 | 1 40 | 8 12 | 4 15 27 | 22 51 | 7·2 | 20 43 | 4 55 | 13 7 |
| 22... | 22 24 48 | 11 2 | 7·6 | 17 19 | 22 26 | 3 33 | 1 44 58 | 10 34 | 11·4 | 18 48 | 1 46 | 8 44 | 4 40 20 | 23 45 | 6·8 | 20 22 | 4 41 | 13 0 |
| Apr. 1... | 23 8 38 | 7 53 | 6·4 | 17 8 | 22 31 | 3 54 | 2 31 27 | 15 7 | 11·8 | 18 29 | 1 53 | 9 17 | 5 5 51 | 24 25 | 6·4 | 20 3 | 4 27 | 12 51 |
| 11... | 0 2 33 | 2 28 S. | 5·8 | 16 55 | 22 47 | 4 39 | 3 19 25 | 19 4 | 12·3 | 18 14 | 2 2 | 9 48 | 5 31 51 | 24 49 | 6·0 | 19 47 | 4 14 | 12 41 |
| 21... | 1 5 2 | 4 45 N. | 5·2 | 16 43 | 23 11 | 5 39 | 4 8 59 | 22 13 | 12·8 | 18 5 | 2 12 | 10 19 | 5 58 8 | 24 57 | 5·8 | 19 31 | 4 1 | 12 29 |
| May 1... | 2 18 23 | 13 7 | 5·0 | 16 34 | 23 46 | 6 58 | 4 59 56 | 24 22 | 13·4 | 18 0 | 2 23 | 10 46 | 6 24 36 | 24 49 | 5·6 | 19 21 | 3 48 | 12 15 |
| 11... | 3 42 59 | 20 47 | 5·2 | 16 28 | 0 27 | 8 26 | 5 51 33 | 25 25 | 14·2 | 18 5 | 2 36 | 11 7 | 6 51 5 | 24 23 | 5·4 | 19 11 | 3 35 | 11 59 |
| 21... | 5 6 29 | 25 3 | 6·0 | 16 43 | 1 11 | 9 39 | 6 42 50 | 25 19 | 15·2 | 18 16 | 2 47 | 11 18 | 7 17 28 | 23 41 | 5·3 | 19 4 | 3 22 | 11 40 |
| 31... | 6 12 31 | 25 26 | 7·4 | 17 6 | 1 38 | 10 10 | 7 32 41 | 24 5 | 16·2 | 18 36 | 2 58 | 11 20 | 7 43 38 | 22 43 | 5·2 | 18 57 | 3 8 | 11 19 |
| June 10... | 6 52 39 | 23 26 | 9·2 | 17 21 | 1 38 | 9 55 | 8 20 7 | 21 51 | 17·6 | 19 1 | 3 6 | 11 11 | 8 9 30 | 21 29 | 5·1 | 18 52 | 2 55 | 10 58 |
| 20... | 7 1 40 | 20 42 | 11·2 | 17 6 | 1 8 | 9 6 | 9 4 28 | 18 47 | 19·2 | 19 25 | 3 10 | 10 55 | 8 35 0 | 20 2 | 5·0 | 18 48 | 2 41 | 10 34 |
| 30.. | 6 42 38 | 18 44 | 11·8 | 16 24 | 0 9 | 7 54 | 9 45 22 | 15 4 | 21·2 | 19 49 | 3 12 | 10 35 | 9 0 8 | 18 21 | 4·9 | 18 45 | 2 27 | 10 9 |
| July 10... | 6 22 44 | 18 43 | 10·4 | 15 20 | 23 5 | 6 50 | 10 22 31 | 10 55 | 23·6 | 20 10 | 3 10 | 10 10 | 9 24 52 | 16 28 | 4·8 | 18 41 | 2 12 | 9 43 |
| 20... | 6 33 40 | 20 23 | 8·0 | 14 46 | 22 41 | 6 37 | 10 55 38 | 6 33 | 26·6 | 20 26 | 3 3 | 9 40 | 9 49 14 | 14 24 | 4·9 | 18 38 | 1 57 | 9 16 |
| 30... | 7 23 35 | 21 38 | 6·2 | 14 51 | 22 55 | 6 59 | 11 24 4 | 2 12 N. | 30·4 | 20 37 | 2 52 | 9 7 | 10 13 17 | 12 11 | 4·6 | 18 35 | 1 42 | 8 49 |
| Aug. 9 .. | 8 41 51 | 19 38 | 5·2 | 15 44 | 23 35 | 7 26 | 11 46 31 | 1 53 S. | 35·4 | 20 40 | 2 35 | 8 30 | 10 37 5 | 9 50 | 4·6 | 18 32 | 1 26 | 8 20 |
| 19... | 10 3 1 | 13 50 | 5·0 | 16 57 | 0 13 | 7 29 | 12 0 49 | 5 21 | 41·4 | 20 34 | 2 10 | 7 46 | 11 0 42 | 7 23 | 4·5 | 18 29 | 1 10 | 7 51 |
| 29... | 11 12 46 | 6 20 N. | 5·0 | 18 7 | 0 43 | 7 19 | 12 4 0 | 7 42 | 48·4 | 20 9 | 1 34 | 6 59 | 11 24 14 | 4 50 | 4·4 | 18 26 | 0 54 | 7 28 |
| Sept. 8... | 12 12 9 | 1 16 S. | 5·2 | 19 5 | 1 3 | 7 1 | 11 53 46 | 8 15 | 54·4 | 19 22 | 0 44 | 6 6 | 11 47 46 | 2 14 N. | 4·4 | 18 23 | 0 38 | 6 53 |
| 18... | 13 4 21 | 8 13 | 5·6 | 19 54 | 1 16 | 6 38 | 11 33 29 | 6 34 | 59·0 | 18 9 | 23 39 | 5 9 | 12 11 25 | 0 24 S. | 4·4 | 18 21 | 0 23 | 6 25 |
| 28... | 13 49 51 | 13 59 | 6·4 | 20 31 | 1 22 | 6 13 | 11 14 18 | 3 25 | 56·4 | 16 55 | 22 41 | 4 27 | 12 35 17 | 3 3 | 4·4 | 18 18 | 0 7 | 5 56 |
| Oct. 8.. | 14 23 13 | 17 44 | 7·6 | 20 46 | 1 16 | 5 46 | 11 7 6 | 0 30 S. | 50·2 | 15 54 | 21 56 | 3 58 | 12 59 29 | 5 41 | 4·4 | 18 15 | 23 50 | 5 25 |
| 18 . | 14 26 13 | 17 29 | 9·4 | 20 8 | 0 39 | 5 10 | 11 14 36 | 1 3 N. | 43·2 | 15 15 | 21 25 | 3 34 | 13 24 8 | 8 17 | 4·5 | 18 14 | 23 36 | 4 58 |
| 28... | 13 48 19 | 11 9 | 9·4 | 18 8 | 23 14 | 2 20 | 11 33 51 | 1 4 N. | 37·0 | 14 57 | 21 6 | 3 15 | 13 49 21 | 10 47 | 4·6 | 18 13 | 23 22 | 4 31 |
| Nov. 7... | 13 41 18 | 8 11 | 7·2 | 17 12 | 22 34 | 3 56 | 12 1 10 | 0 13 S. | 32·0 | 14 52 | 20 55 | 2 58 | 14 15 14 | 13 11 | 4·6 | 18 13 | 23 8 | 4 3 |
| 17 .. | 14 22 47 | 12 5 | 5·8 | 17 36 | 22 38 | 3 40 | 12 33 56 | 2 28 | 28·0 | 14 56 | 20 48 | 2 40 | 14 41 52 | 15 27 | 4·6 | 18 12 | 22 55 | 3 38 |
| 27.. | 15 20 41 | 17 25 | 5·0 | 18 27 | 22 58 | 3 29 | 13 10 25 | 5 24 | 24·8 | 15 9 | 20 46 | 2 21 | 15 9 20 | 17 31 | 4·7 | 18 12 | 22 43 | 3 14 |
| Dec. 7... | 16 24 15 | 21 50 | 4·8 | 19 20 | 23 23 | 3 26 | 13 49 49 | 8 42 | 22·4 | 15 26 | 20 46 | 2 6 | 15 37 40 | 19 22 | 4·8 | 18 12 | 22 32 | 2 52 |
| 17... | 17 31 35 | 24 31 | 4·6 | 20 6 | 23 51 | 3 36 | 14 31 48 | 12 6 | 20·2 | 15 47 | 20 49 | 1 49 | 16 6 53 | 20 56 | 4·8 | 18 13 | 22 22 | 2 31 |
| 27.. | 18 41 47 | 25 3 S. | 4·8 | 20 38 | 0 19 | 4 0 | 15 16 13 | 15 20 S. | 18·6 | 16 11 | 20 54 | 1 37 | 16 36 57 | 22 13 S. | 4·8 | 18 12 | 22 13 | 2 14 |

### *Mercury.*

| | d h | d h | d h | d h |
|---|---|---|---|---|
| Gr. elong. E....Feb. | 9 5; June | 4 13; Oct. | 1 6 | |
| " W....Mar. | 23 18; July | 22 17; Nov. | 10 9 | |
| Sup. conj. ...Jan. | 9 15; May | 4 13; Aug. | 17 7; Dec. | 20 5 |
| Inf. conj. ......Feb. | 24 19; July | 1 2; Oct. | 25 10 | |
| Stationary ...Feb. | 15 3; Mar. | 9 2; June | 17 18; July | 12 5 |
| ...Oct. | 12 22; Nov. | 3 0 | | |

### *Venus.*

| | d h | d h |
|---|---|---|
| Gr. brilliancy | Aug. 13 20; | Oct. 25 22 |
| Inf. Conj. ... | Sept. 18 19 | |
| Gr. elong. E. | July 11 1 | |
| Gr. elong. W. | Nov. 29 3 | |
| Stationary ... | Aug. 26 12; | Oct. 7 18 |

### *Superior Planets.*

| | Conjunction. d h | Opposition. d h | Quadrature. d h | d h | Stationary. d h | d h |
|---|---|---|---|---|---|---|
| *Mars* | ......Oct. 10 21 | | Feb. 5 12 | | | |
| *Jupiter* | ..July 10 1 | | Mar. 17 16; | Oct. 31 8 | Feb. 19 17; | Nov. 25 13 |
| *Saturn* | . .Nov. 2 4 | Apr. 23 21 | Jan. 26 15; | July 23 13 | Feb. 15 5; | July 4 17 |
| *Uranus* | ...Nov. 12 9 | May 8 7 | Feb. 8 8; | Aug 8 7 | Feb. 22 14; | July 24 17 |
| *Neptune* | .June 6 0 | Dec. 8 11 | Mar. 3 8; | Sept. 10 13 | Feb. 21 22; | Sept. |

### Jupiter (♃).

### Saturn (♄).

| 1895. | R.A. Noon. | Dec. Noon. | Diam. | Rises. | Transits. | Sets. | R.A. Noon. | Dec. Noon. | Diam. | Rises. | Transits. | Sets. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h m s | ° ′ | ″ | h m | h m | h m | h m s | ° ′ | ″ | h m | h m | h m |
| Jan. 1 | 5 59 59 | 23 15 N. | 44·2 | 2 59 | 11 14 | 19 29 | 14 16 22 | 11 9 S. | 14·8 | 14 24 | 19 30 | 0 36 |
| 21 | 5 49 59 | 23 17 | 42·8 | 1 31 | 9 46 | 18 1 | 14 20 53 | 11 27 | 15·2 | 13 10 | 18 15 | 23 20 |
| Feb. 10 | 5 44 24 | 23 18 | 40·6 | 0 7 | 8 22 | 16 37 | 14 22 55 | 11 32 | 15·8 | 11 55 | 16 59 | 22 3 |
| Mar. 2 | 5 44 29 | 23 21 | 38·2 | 22 47 | 7 3 | 15 19 | 14 22 17 | 11 24 | 16·2 | 10 34 | 15 39 | 20 44 |
| 22 | 5 50 6 | 23 25 | 35·8 | 21 34 | 5 50 | 14 6 | 14 19 10 | 11 4 | 16·6 | 9 11 | 14 18 | 19 25 |
| Apr. 11 | 6 0 25 | 23 29 | 33·8 | 20 25 | 4 42 | 12 59 | 14 14 12 | 10 36 | 17·0 | 7 43 | 12 54 | 18 5 |
| May 1 | 6 14 23 | 23 28 | 32·1 | 19 20 | 3 37 | 11 54 | 14 8 27 | 10 6 | 17·0 | 6 18 | 11 30 | 16 42 |
| 21 | 6 30 56 | 23 21 | 30·9 | 18 19 | 2 35 | 10 51 | 14 3 4 | 9 39 | 16·8 | 4 50 | 10 6 | 15 22 |
| June 10 | 6 49 11 | 23 6 | 30·1 | 17 20 | 1 34 | 9 48 | 13 59 8 | 9 22 | 16·4 | 3 27 | 8 43 | 13 59 |
| 30 | 7 8 18 | 22 41 | 29·7 | 16 24 | 0 35 | 8 46 | 13 57 20 | 9 18 | 15·8 | 2 7 | 7 23 | 12 39 |
| July 20 | 7 27 34 | 22 7 | 29·5 | 15 25 | 23 32 | 7 39 | 13 58 0 | 9 27 | 15·4 | 0 49 | 6 5 | 11 21 |
| Aug. 9 | 7 46 18 | 21 26 | 29·8 | 14 29 | 22 32 | 6 35 | 14 1 5 | 9 49 | 14·8 | 23 35 | 4 49 | 10 3 |
| 29 | 8 3 50 | 20 40 | 30·7 | 13 33 | 21 31 | 5 29 | 14 6 19 | 10 22 | 14·5 | 22 25 | 3 36 | 8 47 |
| Sept. 18 | 8 19 27 | 19 54 | 31·6 | 12 36 | 20 28 | 4 20 | 14 13 19 | 11 3 | 14·1 | 21 17 | 2 24 | 7 31 |
| Oct. 8 | 8 32 20 | 19 13 | 33·6 | 11 34 | 19 22 | 3 10 | 14 21 38 | 11 48 | 13·9 | 20 11 | 1 14 | 6 17 |
| 28 | 8 41 37 | 18 42 | 35·4 | 10 27 | 18 12 | 1 57 | 14 30 44 | 12 35 | 13·7 | 19 5 | 0 4 | 5 3 |
| Nov. 17 | 8 46 24 | 18 27 | 37·6 | 9 15 | 16 58 | 0 41 | 14 40 4 | 13 19 | 13·7 | 17 58 | 22 52 | 3 46 |
| Dec. 7 | 8 46 0 | 18 33 | 40·0 | 7 55 | 15 39 | 23 23 | 14 49 3 | 13 59 | 13·9 | 16 51 | 21 42 | 2 33 |
| 27 | 8 40 26 | 18 59 N. | 41·8 | 6 28 | 14 15 | 22 2 | 14 57 3 | 14 32 S. | 14·3 | 15 43 | 20 31 | 1 19 |

### Uranus (♅).

### Neptune (♆).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. 1 | 15 5 27 | 17 5 S. | 3·7 | 15 45 | 20 19 | 0 51 | 4 50 4 | 20 57 N. | 2·7 | 2 5 | 10 5 | 18 5 |
| 31 | 15 9 24 | 17 20 | 3·7 | 13 52 | 18 24 | 22 56 | 4 47 39 | 20 54 | 2·6 | 0 3 | 8 4 | 16 5 |
| Mar. 2 | 15 10 15 | 17 24 | 3·8 | 11 55 | 16 27 | 20 59 | 4 47 9 | 20 55 | 2·6 | 22 6 | 6 6 | 14 6 |
| Apr. 1 | 15 7 57 | 17 14 | 3·8 | 9 54 | 14 27 | 19 0 | 4 48 48 | 20 59 | 2·6 | 20 10 | 4 10 | 12 10 |
| May 1 | 15 3 29 | 16 56 | 3·8 | 7 50 | 12 24 | 16 58 | 4 52 14 | 21 6 | 2·5 | 18 14 | 2 15 | 10 16 |
| 31 | 14 58 33 | 16 35 | 3·8 | 5 45 | 10 22 | 14 59 | 4 56 45 | 21 14 | 2·5 | 16 21 | 0 22 | 8 23 |
| June 30 | 14 54 58 | 16 21 | 3·7 | 3 42 | 8 20 | 12 58 | 5 1 27 | 21 21 | 2·5 | 14 23 | 22 25 | 6 27 |
| July 30 | 14 54 0 | 16 17 | 3·7 | 1 43 | 6 21 | 10 59 | 5 5 29 | 21 26 | 2·5 | 12 28 | 20 31 | 4 32 |
| Aug. 29 | 14 56 5 | 16 27 | 3·6 | 23 48 | 4 26 | 9 2 | 5 8 2 | 21 28 | 2·6 | 10 32 | 18 35 | 2 38 |
| Sept. 28 | 15 0 55 | 16 48 | 3·6 | 21 58 | 2 33 | 7 8 | 5 8 35 | 21 28 | 2·6 | 8 34 | 16 38 | 0 40 |
| Oct. 28 | 15 7 41 | 17 17 | 3·5 | 20 9 | 0 41 | 5 13 | 5 7 5 | 21 25 | 2·6 | 6 35 | 14 38 | 22 41 |
| Nov. 27 | 15 15 10 | 17 47 | 3·4 | 18 18 | 22 47 | 3 17 | 5 4 0 | 21 20 | 2·7 | 4 35 | 12 37 | 20 39 |
| Dec. 27 | 15 22 2 | 18 13 S. | 3·4 | 16 29 | 20 56 | 1 23 | 5 0 26 | 21 15 N. | 2·7 | 2 34 | 10 36 | 18 38 |

### Ceres.

### Pallas.

| 1895. | R.A. Noon. | Dec. Noon. | Transits. | 1895. | R.A. Noon. | Dec. Noon. | Transits. |
|---|---|---|---|---|---|---|---|
| | h m | ° ′ | h m | | h m | ° ′ | h m |
| May 9 ... | 18 48 | 24 0 S. | 15 37 | Apr. 27 ... | 17 48 | 20 32 N. | 15 24 |
| June 2 ... | 18 38 | 25 36 | 13 53 | May 21 ... | 17 36 | 24 16 | 13 37 |
| 26 ... | 18 17 | 27 15 | 11 57 | June 14 ... | 17 16 | 25 31 | 11 43 |
| July 20 ... | 17 56 | 28 23 | 10 2 | July 8 ... | 16 58 | 23 51 | 9 52 |
| Aug. 13 ... | 17 47 | 28 56 | 8 18 | Aug. 1 ... | 16 50 | 20 8 | 8 10 |
| Sept. 6 ... | 17 52 | 29 12 | 6 50 | 25 ... | 16 54 | 15 37 | 6 39 |
| 30 ... | 18 11 | 29 16 S. | 5 35 | Sept. 18 ... | 17 8 | 11 13 N. | 5 19 |

### Juno.

### Vesta.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| June 2 ... | 19 41 | 4 41 S. | 14 56 | July 8 ... | 22 54 | 13 39 S. | 15 47 |
| 26 ... | 19 27 | 4 17 | 13 7 | Aug. 1 ... | 22 50 | 16 11 | 14 8 |
| July 20 ... | 19 7 | 5 20 | 11 12 | 25 ... | 22 32 | 19 30 | 12 15 |
| Aug. 13 ... | 18 50 | 7 31 | 9 21 | Sept. 18 ... | 22 12 | 21 38 | 10 21 |
| Sept. 6 ... | 18 45 | 10 3 | 7 42 | Oct. 12 ... | 22 5 | 21 36 | 8 40 |
| 30 .. | 18 54 | 12 16 | 6 18 | Nov. 5 ... | 22 14 | 19 49 | 7 15 |
| Oct. 24 ... | 19 16 | 13 45 S. | 5 5 | 29 ... | 22 35 | 16 54 S. | 6 2 |

*The times of rising and setting correspond to the adjacent transit, irrespective of the day given in be first column.*

# ECLIPSES IN 1895.

In the year 1895 there will be three Eclipses of the Sun and two of the Moon.

## I.—*A Total Eclipse of the Moon, March* 10.

Visible at Greenwich.

Greenwich M.T. of ☍ in R.A.: Mar. 10$^d$ 15$^h$ 31$^m$ 26$^s$·0.

☾'s R.A. 11$^h$ 24$^m$ 27$^s$·38. Hourly motion 132$^s$·52. ☉'s 9$^s$·19.

| | ° | ′ | ″ | | | ′ | ″ |
|---|---|---|---|---|---|---|---|
| ☾'s Declination ............ | 3 | 59 | 35·0 N. | Hourly motion ...... | | 17 | 54·3 S. |
| ☉'s Declination ............ | 3 | 50 | 3·6 S. | Hourly motion ...... | | | 58·8 N. |
| ☾'s Equat. Hor. Parallax | | 60 | 53·2 | True Semidiameter... | | 16 | 37·1 |
| ☉'s Equat. Hor. Parallax | | | 8·9 | True Semidiameter ... | | 16 | 7·8 |

| | h | m | | h | m |
|---|---|---|---|---|---|
| First contact with Penumbra ...... | 12 | 58·4 | With Shadow | 13 | 53·9 |
| Beginning of Total Phase ............ | 14 | 51·8 | End | 16 | 26·6 |
| Second contact with Penumbra...... | 18 | 20·0 | With Shadow | 17 | 24·5 |

Magnitude of the Eclipse (Moon's diameter = 1) 1·619.

The first contact with the Shadow occurs at 127° from the North Point of the Moon's limb towards the East.

The Moon will be seen in the shadow in longitudes from 5$^h$ E. to 12$^h$ W.

## II.—*A Partial Eclipse of the Sun, March* 25.

Visible at Greenwich and throughout the British Isles, except a portion of the county of Kent. Data for some places are as follows (the times are local):—

| | Begins. | | Greatest phase. | | Ends. | | Angle from n.p. first contact. | Magnitude. |
|---|---|---|---|---|---|---|---|---|
| | h | m | h | m | h | m | ° | |
| Greenwich......... | 21 | 56·2 | 22 | 10·2 | 22 | 22·9 | 49 W. | 0·013 |
| Cambridge......... | 21 | 56·0 | 22 | 12·3 | 22 | 27·5 | 50 W. | 0·018 |
| Oxford ............ | 21 | 44·4 | 22 | 4·7 | 22 | 24·0 | 53 W. | 0·028 |
| Edinburgh......... | 21 | 32·7 | 22 | 4·3 | 22 | 35·5 | 60 W. | 0·076 |
| Dublin ............ | 21 | 9·8 | 21 | 43·6 | 22 | 17·5 | 62 W. | 0·090 |

In Newfoundland, Nova Scotia, and the neighbourhood the Sun will rise partially eclipsed on March 25.

## III.—*A Partial Eclipse of the Sun, August* 20.

Invisible at Greenwich. Visible in Russia and Western Asia.

## IV.—*A Total Eclipse of the Moon, Sept.* 3.

Partly visible at Greenwich.

| | h | m | | h | m |
|---|---|---|---|---|---|
| First contact with Penumbra...... | 14 | 49·7 | With Shadow . | 16 | 0·3 |
| Second contact with Penumbra ... | 24 | 4·3 | With Shadow . | 19 | 53·7 |
| Beginning of Total phase ......... | 17 | 6·9 | End ............ | 18 | 47·1 |

Magnitude of Eclipse (Moon's diameter = 1) 1·550.

The first contact with the shadow occurs at 54° from the North Point towards the E.

The Moon will be seen in shadow in longitudes from 2½$^h$ E. to 15$^h$ W. of Greenwich. At Greenwich the Moon will set at 17$^h$ 18$^m$.

## V.—*A Partial Eclipse of the Sun, Sept.* 18.

Invisible at Greenwich. Visible in New Zealand and in Eastern Australia, where the Sun will rise partially eclipsed on the morning of Sept. 19.

At Melbourne the Eclipse ends Sept. 18$^d$ 18$^h$ 33$^m$·8 Melbourne mean time, at 145° from the North Point towards the E. (*direct* image).

At Sydney the Eclipse ends Sept. 18$^d$ 18$^h$ 51$^m$·8 Sydney Mean Time, at 149° from the *North Point towards the E.* (*direct* image).

## OCCULTATIONS, 1895. (VISIBLE AT GREENWICH.)

| Date. | Star. | Mag. | Disap. |  | Reap. |  |
|---|---|---|---|---|---|---|
|  |  |  | M.T. | P. | M.T. | P. |
| **Jan.** |  |  | h m | ° | h m | ° |
| 1 | *h*' Aquarii... | 5½ | 7 50 | 117 | 8 23 | 176 |
| 6 | 47 Arietis... | 6 | 8 49 | 66 | 10 4 | 248 |
| 7 | 23 Tauri ... | 5 | 4 0 | 41 | 4 55 | 271 |
| 7 | η Tauri ... | 3 | 4 37. | 31 | 5 29 | 280 |
| 7 | 27 Tauri ... | 4 | 5 10 | 76 | 6 15 | 236 |
| 7 | 28 Tauri ... | 5½ | 5 14 | 60 | 6 20 | 252 |
| 9 | 136 Tauri... | 5 | 3 37 | 110 | 4 22 | 234 |
| 10 | 47 Geminor. | 6 | 7 21 | 66 | 8 16 | 300 |
| 12 | 8 Leonis ... | 6 | 16 8 | 124 | 17 11 | 298 |
| 14 | *r* Leonis ... | 5 | 17 6 | 143 | 18 11 | 291 |
| **Feb.** |  |  |  |  |  |  |
| 2 | B.A.C. 782.. | 6½ | 6 4 | 21 | 7 4 | 281 |
| 3 | 17 Tauri ... | 4 | 14 28 | 58 | 15 14† | 285 |
| 3 | 23 Tauri ... | 5 | 14 57‡ | 105 | 15 42† | 237 |
| 5 | 136 Tauri... | 5 | 16 20 | 139 | 16 54 | 231 |
| 6 | 49 Aurigæ . | 5½ | 5 49 | 31 | 6 25 | 325 |
| 8 | γ Cancri ... | 4½ | 4 39 | 112 | 5 31 | 273 |
| 10 | *c* Leonis ... | 5 | 15 43 | 183 | 16 19 | 249 |
| 12 | *f* Virginis... | 6 | 9 43 | 57 | 10 7 | 8 |
| 27 | 60 Piscium . | 6 | 5 59 | 48 | 7 5 | 251 |
| **Mar.** |  |  |  |  |  |  |
| 4 | B.A.C. 1648 | 6½ | 12 17 | 58 | 13 3 | 308 |
| 8 | 8 Leonis ... | 6 | 14 56 | 81 | 15 40 | 336 |
| 10 | *r* Leonis ... | 5 | 14 57 | 84 | 15 44 | 345 |
| 12 | 49 Virginis . | 6 | 12 3 | 179 | 12 44 | 254 |
| 15 | 4 Scorpii ... | 6 | 13 46 | 119 | 15 0 | 288 |
| 29 | ε Arietis ... | 4½ | 6 43 | 12 | 7 15 | 315 |
| **Apr.** |  |  |  |  |  |  |
| 4 | 83 Cancri... | 6 | 16 13† | 159 | 16 46† | 247 |
| 6 | *c* Leonis ... | 5 | 12 58 | 162 | 13 47 | 267 |
| 8 | 28 Virginis.. | 6 | 11 15 | 197 | 11 40 | 239 |
| 15 | B.A.C. 6628 | 6 | 15 51 | 126 | 16 48 | 213 |
| 28 | 136 Tauri... | 5 | 11 51 | 110 | 12 36† | 258 |
| **May** |  |  |  |  |  |  |
| 4 | *r* Leonis ... | 5 | 7 50 | 120 | 9 0 | 315 |
| 7 | B.A.C. 4722 | 6 | 15 42† | 41 | 16 4† | 0 |
| 9 | π Scorpii ... | 3 | 10 15 | 77 | 11 14 | 328 |
| 11 | γ' Sagittarii. | 4 | 15 11 | 148 | 15 50 | 205 |
| 16 | 45 Aquarii .. | 6 | 14 29 | 79 | 15 40 | 226 |
| 30 | 45 Leonis... | 6 | 10 54 | 183 | 11 20 | 237 |
| 30 | ρ Leonis .. | 4 | 12 51‡ | 125 | 13 40† | 288 |
| **June** |  |  |  |  |  |  |
| 6 | *r* Scorpii .. | 3½ | 10 44 | 185 | 10 59 | 206 |
| 9 | B.A.C. 6666 | 6 | 10 44* | 63 | 11 56 | 283 |
| 26 | Regulus ... | 1½ | 8 4 | 147 | 8 56 | 275 |
| **July** |  |  |  |  |  |  |
| 9 | δ Capricorni | 3 | 13 56 | 31 | 15 10 | 263 |
| 10 | 58 Aquarii | 6 | 14 14 | 27 | 15 26 | 261 |
| 16 | 47 Arietis .. | 6 | 12 38 | 91 | 13 27 | 221 |
| 17 | 27 Tauri ... | 4 | 11 18† | 104 | 11 59 | 222 |
| 17 | 28 Tauri ... | 5½ | 11 18† | 86 | 12 4 | 241 |
| 24 | **Venus** ... | ... | 20 23† | 151 | 21 9 | 261 |
| **Aug.** |  |  | h m | ° | h m |  |
| 6 | 42 Aquarii . | 6 | 12 25 | 73 | 13 41 |  |
| 7 | 81 Aquarii . | 6 | 13 44 | 60 | 15 2 |  |
| 7 | 82 Aquarii . | 6 | 15 17 | 10 | 16 14 |  |
| 12 | B.A.C. 782.. | 6½ | 9 11† | 52 | 10 1 |  |
| 12 | μ Arietis ... | 5½ | 13 44 | 22 | 14 38 |  |
| 15 | B.A.C. 1746 | 6½ | 15 3 | 156 | 15 17 |  |
| 27 | B.A.C. 5603 | 6½ | 9 12 | 85 | 10 23† |  |
| 30 | B.A.C. 6666 | 6 | 6 23 | 50 | 7 35 |  |
| **Sept.** |  |  |  |  |  |  |
| 2 | ι Aquarii ... | 4 | 13 54 | 87 | 14 53 |  |
| 3 | 64 Aquarii . | 6½ | 6 12† | 41 | 7 10 |  |
| 4 | B.A.C. 8134 | 6½ | 5 58† | 74 | 6 57 |  |
| 6 | 60 Piscium . | 6 | 7 7* | 108 | 7 46 |  |
| 6 | 62 Piscium . | 6 | 8 4 | 8 | 8 40 |  |
| 15 | 83 Cancri... | 6 | 14 41 | 111 | 15 35 |  |
| 29 | δ Capricorni | 3 | 8 48 | 50 | 10 8 |  |
| 30 | 58 Aquarii . | 6 | 9 9 | 56 | 10 30 |  |
| **Oct.** |  |  |  |  |  |  |
| 2 | B.A.C. 8311 | 6½ | 7 56 | 33 | 9 4 |  |
| 3 | δ Piscium... | 4½ | 16 16 | 82 | 17 16 |  |
| 6 | ε Arietis ... | 4½ | 9 33 | 23 | 10 23 |  |
| 7 | 17 Tauri ... | 4 | 6 17* | 67 | 7 6 |  |
| 7 | 16 Tauri ... | 5½ | 6 29 | 22 | 7 1 |  |
| 7 | 20 Tauri ... | 5 | 6 54 | 21 | 7 26 |  |
| 7 | 23 Tauri ... | 5 | 6 58 | 140 | 7 17 |  |
| 7 | η Tauri ... | 3 | 7 18 | 112 | 7 57 |  |
| 13 | Regulus ... | 1½ | 22 49 | 126 | 23 53 |  |
| 25 | 17 Capricor. | 6 | 9 44 | 31 | 10 43† |  |
| 28 | 81 Aquarii . | 6 | 9 30 | 112 | 10 8 |  |
| 28 | 82 Aquarii . | 6 | 10 33 | 54 | 11 46 |  |
| **Nov.** |  |  |  |  |  |  |
| 2 | ε Arietis ... | 4½ | 17 43 | 78 | 18 41 |  |
| 3 | 66 Arietis... | 6½ | 4 53 | 116 | 5 29 |  |
| 3 | 16 Tauri ... | 5½ | 13 21 | 122 | 14 12 |  |
| 3 | 19 Tauri ... | 5 | 13 29 | 85 | 14 46 |  |
| 3 | 20 Tauri ... | 5 | 13 57 | 120 | 14 51 |  |
| 4 | χ' Tauri ... | 5½ | 4 31† | 112 | 5 10 |  |
| 5 | B.A.C. 1746 | 6½ | 10 19 | 104 | 11 20 |  |
| 10 | 45 Leonis... | 6 | 12 59 | 135 | 13 52 |  |
| 10 | ρ Leonis ... | 4 | 15 27 | 103 | 16 30 |  |
| 10 | 49 Leonis... | 6 | 17 15 | 164 | 18 8 |  |
| 27 | 62 Piscium . | 6 | 4 56 | 74 | 6 3 |  |
| 27 | δ Piscium... | 4½ | 5 31 | 33 | 6 39 |  |
| 29 | μ Arietis ... | 5½ | 17 44 | 53 | 18 31† |  |
| **Dec.** |  |  |  |  |  |  |
| 2 | B.A.C. 1746 | 6½ | 19 18 | 42 | 19 49 |  |
| 7 | Regulus ... | 1½ | 9 35† | 81 | 10 21 |  |
| 10 | ψ Virginis .. | 5 | 16 57 | 65 | 17 30 |  |
| 11 | 85 Virginis | 6 | 16 23 | 127 | 17 26 |  |
| 28 | 16 Tauri ... | 5½ | 5 2 | 79 | 6 7 |  |
| 28 | 17 Tauri ... | 4 | 5 11 | 126 | 5 45 |  |
| 28 | 19 Tauri ... | 5 | 5 22 | 50 | 6 26 |  |
| 28 | 20 Tauri ... | 5 | 5 33 | 82 | 6 39 |  |
| 30 | 136 Tauri... | 5 | 9 28 | 122 | 10 29 |  |

* *Star rising.* ‡ Star setting. † Star below horizon.

*The angles (P) are reckoned from the true N. point in the direction N., E., S., W., i.e. from the bottom of the Moon's inverted image towards the right.*

The following "near approaches" are also given in the 'Nautical Almanac,' and are especially interesting to observers rather South and rather North of Greenwich respectively:—

*North Near Approaches.*

| Date. | Star. | Mag. | G.M.T. | Angle. | Date. | Star. | Mag. | G.M.T. | Angle. |
|---|---|---|---|---|---|---|---|---|---|
| Jan. | | | h m | ° | June | | | h m | ° |
| 7 | 17 Tauri...... | 4 | 3 55 | 337 | 25 | 83 Cancri ... | 6 | 10 47 | 23 |
| 11 | γ Cancri...... | 4½ | 19 25 | 23 | 29 | 28 Virginis. . | 6 | 8 8 | 34 |
| 16 | 50 Virginis... | 6 | 18 12 | 35 | July | | | | |
| Feb. | | | | | 12 | B.A.C. 8311 . | 6½ | 13 38 | 326 |
| 3 | 16 Tauri...... | 5½ | 14 51 | 352 | Aug. | | | | |
| 3 | 20 Tauri ... | 5 | 15 14 | 351 | 4 | 17 Capricorni | 6 | 14 51 | 331 |
| 13 | B.A.C. 4531 . | 6 | 13 36 | 36 | Sept. | | | | |
| Mar. | | | | | 30 | σ Aquarii ... | 4½ | 9 29 | 324 |
| 7 | γ Cancri...... | 4½ | 17 24 | 21 | Oct. | | | | |
| 12 | 50 Virginis... | 6 | 12 49 | 36 | 7 | 19 Tauri ... | 5 | 6 56 | 342 |
| 15 | π Scorpii ... | 3 | 16 5 | 20 | Nov. | | | | |
| Apr. | | | | | 2 | μ Arietis ... | 5½ | 8 28 | 331 |
| 2 | 47 Geminor . | 6 | 12 58 | 15 | Dec. | | | | |
| 8 | *f* Virginis ... | 6 | 7 29 | 34 | 6 | 80 Cancri ... | 6½ | 8 38 | 15 |
| May | | | | | | | | | |
| 6 | 50 Virginis... | 6 | 8 0 | 37 | | | | | |

*South Near Approaches.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Jan. | | | h m | ° | Oct. | | | h m | ° |
| 16 | 49 Virginis... | 6 | 17 48 | 217 | 3 | 62 Piscium . . | 6 | 16 21 | 152 |
| Feb. | | | | | 6 | 47 Arietis ... | 6 | 8 56 | 153 |
| 3 | 66 Arietis ... | 6½ | 6 47 | 158 | 7 | 27 Tauri ... | 4 | 8 18 | 160 |
| 12 | 28 Virginis... | 6 | 13 38 | 217 | 7 | 28 Tauri ... | 5½ | 8 18 | 160 |
| May | | | | | 9 | 136 Tauri ... | 5 | 12 12 | 172 |
| 6 | 49 Virginis... | 6 | 7 38 | 216 | 27 | 42 Aquarii... | 6 | 8 30 | 143 |
| 9 | 4 Scorpii ... | 6 | 9 21 | 204 | Nov. | | | | |
| June | | | | | 3 | 17 Tauri ... | 4 | 13 47 | 163 |
| 2 | ψ Virginis... | 5 | 8 46 | 217 | 7 | κ Geminor... | 3½ | 14 54 | 193 |
| Aug. | | | | | Dec. | | | | |
| 13 | 66 Arietis ... | 6½ | 10 51 | 159 | 27 | ε Arietis...... | 4½ | 10 36 | 160 |
| | | | | | 31 | 39 Geminor.. | 6½ | 11 16 | 189 |

## *Occultations during the Total Lunar Eclipse of* 1895, *March* 10.

The following is a list of the Stars contained in the Bonn 'Durchmusterung' which will be occulted during or shortly before or after Totality in the above eclipse.

| Star. | Mag. | Dis. or Reapp. | Mean Time. | Angle from N. pt. towards E. direct image. |
|---|---|---|---|---|
| | | | h m | c |
| 83 Leonis........................ | 7·5 | D. | 14 17 | 95 |
| Pi. xi. 71 ........................ | 8·0 | D. | 14 18 | 96 |
| τ Leonis ........................ | 5·0 | D. | 14 56 | 86 |
| W.B. xi. 349 ................ | 8·2 | D. | 14 57 | 90 |
| 83 Leonis ...................... | 7·5 | R. | 15 12 | 338 |
| Pi. xi. 71 ........................ | 8·0 | R. | 15 13 | 338 |
| W.B. xi. 365 ................ | 8·2 | D. | 15 14 | 82 |
| B.D.+3° 2501.................. | 9·5 | R. | 15 16 | 286 |
| W.B. xi. 372 ................ | 8·8 | D. | 15 36 | 68 |
| τ Leonis ........................ | 5·0 | R. | 15 43 | 345 |
| W.B. xi. 349.................... | 8·2 | R. | 15 48 | 340 |
| B.D.+3° 2510.................. | 9·4 | D. | 15 53 | 119 |
| W.B. xi. 372 ................ | 8·8 | R. | 16 9 | 0 |
| B.D.+3° 2510 ................ | 9·4 | R. | 16 57 | 306 |

## Apparent Disk of Mars, 1895.

| | | | | | |
|---|---|---|---|---|---|
| Jan. 1 | 0·896 | May 31 | 0·951 | Sept. 28 | 0·999 |
| 31 | 0·888 | June 30 | 0·970 | Oct. 28 | 0·999 |
| Mar. 2 | 0·896 | July 30 | 0·984 | Nov. 27 | 0·993 |
| April 1 | 0·913 | Aug. 29 | 0·994 | Dec. 27 | 0·987 |
| May 1 | 0·931 | | | | |

The numbers in this table are the versed sines of the illuminated disk, the apparent diameter of the planet being taken as unity.

Mars not being in opposition during the year 1895 the satellites will not be visible.

## CONFIGURATIONS OF JUPITER'S SATELLITES
### FOR AN INVERTING TELESCOPE.

| Day. | Jan. $11^h$ | Feb. $10^h$ | March. $9^h$ | April. $9^h$ | May. $9^h$. | June. $9^h$ | Aug. $16^h$ | Sept. $15\frac{1}{2}^h$ | Oct. $15^h$ | Nov. $14\frac{1}{2}^h$ | Dec. $14^h$ | Day. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1O243 | 432O1 | 42O13 | 312O4 | 31O4● | 2O143 | | 42O13 | O2134 | 231O4 | 341O2 | 1 |
| 2 | 2O134 | 314O2 | 431O2 | 324O1 | O1324 | 1O34● | | 412O3 | 1O324 | 3O214 | ♃3O14 | 2 |
| 3 | 21O34 | 32O14 | 43O12 | 41O32 | 12O34 | 3O124 | | 4O123 | 23O14 | 31O24 | 21O34 | 3 |
| 4 | ♃3O24 | 23O4● | 4321O | 4O213 | 2O134 | 312O4 | | 413O2 | 3124O | 2O314 | O2134 | 4 |
| 5 | 3O124 | 1O234 | 42O1● | 421O3 | ♃1O42 | 32O14 | | 432O1 | 43O12 | 21O43 | 1O234 | 5 |
| 6 | 321O4 | O1234 | 41O23 | 42O13 | 34O12 | 31O24 | | 43O2● | 4O2●● | O4123 | 2O314 | 6 |
| 7 | 2O314 | 21O34 | ♃42O3 | 43O2● | 4321O | ♃O234 | | 431O2 | ♃42O3 | 4O23● | 32O4● | 7 |
| 8 | 1O423 | 23O14 | 2O13● | 4312O | 4321O | 24O13 | 321O4 | 2O13● | 4O213 | 4231O | ♃3O24 | 8 |
| 9 | ♃4O13 | 31O24 | 31O24 | 324O1 | 4O132 | 412O3 | 3O124 | 21O43 | 41O23 | 43O21 | 3O214 | 9 |
| 10 | 421O3 | ♃3O14 | 3O124 | 1O32● | 412O3 | 43O 2 | 1O234 | O1234 | 423O1 | 431O2 | 214O3 | 10 |
| 11 | 43O12 | 243O● | 321O4 | O1243 | 42O13 | ♃431O | 2O134 | ♃1O24 | 3421O | 42O1● | 4O213 | 11 |
| 12 | 43O2● | 41O23 | 23O14 | 21O34 | 41O32 | | 1O234 | 32O14 | 3O12● | 421O3 | 41O23 | 12 |
| 13 | 4321O | 4O123 | 1O234 | 2O134 | 34O12 | | O1324 | 3O4●● | 31O24 | 4O123 | 42O31 | 13 |
| 14 | 42O1● | 421O3 | ♃O134 | 3O24● | 321O● | | ♃32O1 | 31O24 | 2O134 | O23●● | 4321O | 14 |
| 15 | 41O23 | 42O31 | 2O43● | ♃31O4 | ♃32O4 | | 3421O | 2O134 | O134● | 231O4 | ♃43O2 | 15 |
| 16 | 4O213 | 431O2 | 134O2 | 32O14 | O1324 | | 43O12 | 21O43 | 1O234 | 3O14● | 43O12 | 16 |
| 17 | 21O34 | 43O21 | 34O12 | 1O24● | ♃1O34 | | 41O32 | 4O23 | ♃2O14 | 31O24 | 421O3 | 17 |
| 18 | 3O14● | 2341O | 4321O | O4123 | 2O134 | | 42O13 | 41O32 | 321O4 | 2O14● | O13●● | 18 |
| 19 | 3O24● | ♃O43● | 423O1 | 241O3 | 1O234 | | 41O3● | 432O1 | 3O124 | 21O34 | 1O243 | 19 |
| 20 | 321O4 | O1243 | 41O32 | 42O13 | 3O124 | | 4O132 | 431O● | 31O42 | O1234 | 2O314 | 20 |
| 21 | 2O14● | 21O34 | 4O213 | 431O2 | 321O4 | | 432O● | ♃43O2 | 24O13 | 1O234 | 321O4 | 21 |
| 22 | 1O234 | 2O314 | 42O3● | ♃43O2 | 32O41 | | 3241O | 42O13 | 4O3●● | ♃23O4 | 3O124 | 22 |
| 23 | O2134 | 31O24 | 413O● | 432O1 | 4O2●● | | 3O142 | 421O3 | 41O23 | 34O1● | 3O24● | 23 |
| 24 | 21O43 | 3O214 | 34O12 | 413O● | 41O23 | | 1O24● | 4O123 | 42O31 | 341O2 | 21O4● | 24 |
| 25 | 34O1● | 321O4 | 312O4 | 4O123 | 42O13 | | 2O134 | 14O32 | 4321O | 432O1 | O143● | 25 |
| 26 | 341O2 | O14●● | 23O14 | 412O3 | 41O3● | | 12O34 | 23O14 | 43O21 | 421O3 | 1O423 | 26 |
| 27 | ♃432O | O423● | 1O324 | 2O413 | 43O12 | | O1324 | 312O4 | 431O2 | 4O213 | 42O13 | 27 |
| 28 | 423O1 | 421O3 | O2134 | 13O24 | 4312O | | ♃31O4 | 3O124 | 24O13 | 41O23 | 4231O | 28 |
| 29 | 41O23 | | 21O34 | 3O124 | 432O1 | | ♃32O4 | ♃O4●● | 21O43 | ♃42O1 | 43O12 | 29 |
| 30 | 4O213 | | ♃O34● | 32O4● | 413O2 | | 3O124 | 21O34 | ♃O243 | 342O● | 43O2● | 30 |
| 31 | 421O3 | | 3O124 | | ♃O243 | | ♃13O2 | | ♃O134 | | 421O● | 31 |

The circle (O) represents Jupiter; ♃ signifies that the satellite is on the disk; ● signifies that the satellite is behind the disk or in the shadow.

## JUPITER'S IVTH SATELLITE.

Greenwich Mean Times of Superior Geocentric Conjunction.

| | h m | | h m | | h m | | h m |
|---|---|---|---|---|---|---|---|
| Jan. 16 ... | 19 52·0 | Apr. 10 ... | 8 50·9 | Aug. 23 ... | 4 20·3 | Oct. 29 ... | 10 5·7 |
| Feb. 2 ... | 10 53·6 | 27 ... | 4 21·6 | Sept. 9 ... | 0 34·8 | Nov. 15 ... | 3 41·8 |
| 19 ... | 1 54·4 | 14 ... | 0 24·8 | 25 ... | 20 22·6 | Dec. 1 ... | 20 17·7 |
| Mar. 7 ... | 19 57·7 | May 30 ... | 20 49·9 | Oct. 12 ... | 15 35·9 | 18 ... | 11 53·8 |
| 24 ... | 13 58·9 | | | | | | |

## JUPITER'S SATELLITES, 1895.

**Phenomena.**

*e*, Signifies Ec. dis.; E, Ec. re.; *o*, Occ. dis.; O, Occ. re.; *t*, Tr. Ing.; T, Tr. Egr.

*January.*

| d | h | m | |
|---|---|---|---|
| 1 | 17 | 39 | i. *o*. |
| | 20 | 9 | i. E. |
| 2 | 8 | 4 | ii. *t*. |
| | 10 | 40 | ii. T. |
| | 14 | 57 | i. *t*. |
| | 17 | 13 | i. T. |
| 3 | 12 | 5 | i. *o*. |
| | 13 | 57 | iii. *t*. |
| | 14 | 37 | i. E. |
| | 16 | 46 | iii. T. |
| 4 | 3 | 0 | ii. *o*. |
| | 6 | 13 | ii. E. |
| | 9 | 23 | i. *t*. |
| | 11 | 39 | i. T. |
| 5 | 6 | 31 | i. *o*. |
| | 9 | 6 | i. E. |
| | 21 | 11 | ii. *t*. |
| | 23 | 48 | ii. T. |
| 6 | 3 | 49 | i. *t*. |
| | 6 | 5 | i. T. |
| 7 | 0 | 57 | i. *o*. |
| | 3 | 23 | iii. *o*. |
| | 3 | 35 | i. E. |
| | 7 | 46 | iii. E. |
| | 16 | 8 | ii. *o*. |
| | 19 | 30 | ii. E. |
| | 22 | 15 | i. *t*. |
| 8 | 0 | 31 | i. T |
| | 19 | 23 | i. *o*. |
| | 22 | 3 | i. E. |
| 9 | 10 | 20 | ii. *t*. |
| | 12 | 57 | ii. T. |
| | 16 | 41 | i. *t*. |
| | 18 | 57 | i. T. |
| 10 | 13 | 50 | i. *o*. |
| | 16 | 32 | i. E. |
| | 17 | 15 | iii. *t*. |
| | 20 | 4 | iii. T. |
| 11 | 5 | 15 | ii. *o*. |
| | 8 | 48 | ii. E. |
| | 11 | 7 | i. *t*. |
| | 13 | 23 | i. T. |
| 12 | 8 | 16 | i. *o*. |
| | 11 | 1 | i. E. |
| | 23 | 28 | ii. *t*. |
| 13 | 2 | 5 | ii. T. |
| | 5 | 33 | i. *t*. |
| | 7 | 50 | i. T. |
| 14 | 2 | 42 | i. *o*. |
| | 5 | 30 | i. E. |
| | 6 | 43 | iii. *o*. |
| | 11 | 48 | iii. E. |
| | 18 | 23 | ii. *o*. |
| | 22 | 6 | ii. E. |

*Jan.* (con.).

| d | h | m | |
|---|---|---|---|
| 15 | 0 | 0 | i. *t*. |
| | 2 | 16 | i. T. |
| | 21 | 9 | i. *o*. |
| | 23 | 59 | i. E. |
| 16 | 12 | 38 | ii. *t*. |
| | 15 | 15 | ii. T. |
| | 18 | 26 | i. *t*. |
| | 20 | 42 | i. T. |
| 17 | 1 | 36 | iv. *e*. |
| | 2 | 8 | iv. E. |
| | 15 | 35 | i. *o*. |
| | 18 | 27 | i. E. |
| | 20 | 35 | iii. *t*. |
| | 23 | 24 | iii. T. |
| 18 | 7 | 31 | ii. *o*. |
| | 11 | 23 | ii. E. |
| | 12 | 52 | i. *t*. |
| | 15 | 8 | i. T. |
| 19 | 10 | 1 | i. *o*. |
| | 12 | 56 | i. E. |
| 20 | 1 | 47 | ii. *t*. |
| | 4 | 24 | ii. T. |
| | 7 | 19 | i. *t*. |
| | 9 | 35 | i. T. |
| 21 | 4 | 28 | i. *o*. |
| | 7 | 25 | i. E. |
| | 10 | 5 | iii. *o*. |
| | 12 | 54 | iii. O. |
| | 13 | 2 | iii. *e*. |
| | 15 | 49 | iii. E. |
| | 20 | 40 | ii. *o*. |
| 22 | 0 | 41 | ii. E. |
| | 1 | 45 | i. *t*. |
| | 4 | 1 | i. T. |
| | 22 | 55 | i. *o*. |
| 23 | 1 | 54 | i. E. |
| | 14 | 58 | ii. *t*. |
| | 17 | 34 | ii. T. |
| | 20 | 12 | i. *t*. |
| | 22 | 28 | i. T. |
| 24 | 17 | 21 | i. *o*. |
| | 20 | 23 | i. E. |
| | 23 | 59 | iii. *t*. |
| 25 | 2 | 48 | iii. T. |
| | 9 | 49 | ii. *o*. |
| | 13 | 59 | ii. E. |
| | 14 | 38 | i. *t*. |
| | 16 | 54 | i. T. |
| 26 | 11 | 48 | i. *o*. |
| | 14 | 52 | i. E. |
| 27 | 4 | 8 | ii. *t*. |
| | 6 | 45 | ii. T. |
| | 9 | 5 | i. *t*. |
| | 11 | 21 | i. T. |

*Jan.* (con.).

| d | h | m | |
|---|---|---|---|
| 28 | 6 | 15 | i. *o*. |
| | 9 | 21 | i. E. |
| | 13 | 32 | iii. *o*. |
| | 16 | 22 | iii. O. |
| | 17 | 3 | iii. *e*. |
| | 19 | 51 | iii. E. |
| | 22 | 58 | ii. *o*. |
| 29 | 3 | 17 | ii. E. |
| | 3 | 32 | i. *t*. |
| | 5 | 48 | i. T. |
| 30 | 0 | 42 | i. *o*. |
| | 3 | 49 | i. E. |
| | 17 | 20 | ii. *t*. |
| | 19 | 57 | ii. T. |
| | 21 | 58 | i. *t*. |
| 31 | 0 | 15 | i. T. |
| | 19 | 9 | i. *o*. |
| | 22 | 18 | i. E. |

*February.*

| d | h | m | |
|---|---|---|---|
| 1 | 3 | 27 | iii. *t*. |
| | 6 | 17 | iii. T. |
| | 12 | 9 | ii. *o*. |
| | 16 | 25 | i. *t*. |
| | 16 | 34 | ii. E. |
| | 18 | 42 | i. T. |
| 2 | 13 | 36 | i. *o*. |
| | 16 | 47 | i. E. |
| | 19 | 26 | iv. *e*. |
| | 20 | 36 | iv. E. |
| 3 | 6 | 31 | ii. *t*. |
| | 9 | 8 | ii. T. |
| | 10 | 52 | i. *t*. |
| | 13 | 9 | i. T. |
| 4 | 8 | 3 | i. *o*. |
| | 11 | 16 | i. E. |
| | 17 | 3 | iii. *o*. |
| | 19 | 54 | iii. O. |
| | 21 | 3 | iii. *e*. |
| | 23 | 52 | iii. E. |
| 5 | 1 | 19 | ii. *o*. |
| | 5 | 19 | i. *t*. |
| | 5 | 52 | ii. E. |
| | 7 | 36 | i. T. |
| 6 | 2 | 30 | i. *o*. |
| | 5 | 45 | i. E. |
| | 19 | 44 | ii. *t*. |
| | 22 | 21 | ii. T. |
| | 23 | 46 | i. *t*. |
| 7 | 2 | 3 | i. T. |
| | 20 | 58 | i. *o*. |
| 8 | 0 | 14 | i. E. |
| | 7 | 0 | iii. *t*. |

*Feb.* (con.).

| d | h | m | |
|---|---|---|---|
| 8 | 9 | 51 | iii. T. |
| | 14 | 30 | ii. *o*. |
| | 18 | 14 | i. *t*. |
| | 21 | 45 | ii. E. |
| | 20 | 30 | i. T. |
| 9 | 15 | 25 | i. *o*. |
| | 18 | 43 | i. E. |
| 10 | 8 | 56 | ii. *t*. |
| | 11 | 33 | ii. T. |
| | 12 | 41 | i. *t*. |
| | 14 | 57 | i. T. |
| 11 | 9 | 52 | i. *o*. |
| | 13 | 12 | i. E. |
| | 20 | 38 | iii. *o*. |
| | 23 | 30 | iii. O. |
| 12 | 1 | 3 | iii. *e*. |
| | 3 | 42 | ii. *o*. |
| | 3 | 54 | iii. E. |
| | 7 | 8 | i. *t*. |
| | 8 | 27 | ii. E. |
| | 9 | 25 | i. T. |
| 13 | 4 | 20 | i. *o*. |
| | 7 | 40 | i. E. |
| | 22 | 11 | ii. *t*. |
| 14 | 0 | 48 | ii. T. |
| | 1 | 36 | i. *t*. |
| | 3 | 52 | i. T. |
| | 22 | 48 | i. *o*. |
| 15 | 2 | 9 | i. E. |
| | 10 | 37 | iii. *t*. |
| | 13 | 29 | iii. T. |
| | 16 | 55 | ii. *o*. |
| | 20 | 3 | i. *t*. |
| | 21 | 45 | ii. E. |
| | 22 | 20 | i. T. |
| 16 | 17 | 15 | i. *o*. |
| | 20 | 38 | i. E. |
| 17 | 11 | 24 | ii. *t*. |
| | 14 | 1 | ii. T. |
| | 14 | 31 | i. *t*. |
| | 16 | 47 | i. T. |
| 18 | 11 | 43 | i. *o*. |
| | 15 | 7 | i. E. |
| 19 | 0 | 18 | iii. *o*. |
| | 2 | 31 | iv. *o*. |
| | 3 | 10 | iii. O. |
| | 3 | 18 | iv. O. |
| | 5 | 4 | iii. *e*. |
| | 6 | 8 | ii. *o*. |
| | 7 | 55 | iii. E. |
| | 8 | 58 | i. *t*. |
| | 11 | 3 | ii. E. |
| | 11 | 15 | i. T. |
| | 13 | 24 | iv. *e*. |

*Feb.* (con.).

| d | h | m | |
|---|---|---|---|
| 19 | 14 | 59 | iv. E. |
| 20 | 6 | 11 | i. *o*. |
| | 9 | 36 | i. E. |
| 21 | 0 | 40 | ii. *t*. |
| | 3 | 17 | ii. T. |
| | 3 | 26 | i. *t*. |
| | 5 | 43 | i. T. |
| 22 | 0 | 39 | i. *o*. |
| | 4 | 5 | i. E. |
| | 14 | 19 | iii. *t*. |
| | 17 | 12 | iii. T. |
| | 19 | 21 | ii. *o*. |
| | 21 | 54 | i. *t*. |
| 23 | 0 | 10 | i. T. |
| | 0 | 20 | ii. E. |
| | 19 | 7 | i. *o*. |
| | 22 | 34 | i. E. |
| 24 | 13 | 54 | ii. *t*. |
| | 16 | 22 | i. *t*. |
| | 16 | 32 | ii. T. |
| | 18 | 38 | i. T. |
| 25 | 13 | 35 | i. *o*. |
| | 17 | 3 | i. E. |
| 26 | 4 | 2 | iii. *o*. |
| | 6 | 56 | iii. O. |
| | 8 | 36 | ii. *o*. |
| | 9 | 4 | iii. *e*. |
| | 10 | 50 | i. *t*. |
| | 11 | 56 | iii. E. |
| | 13 | 6 | i. T. |
| | 13 | 38 | ii. E. |
| 27 | 8 | 3 | i. *o*. |
| | 11 | 8 | iv. *t*. |
| | 11 | 32 | i. E. |
| | 12 | 6 | iv. T. |
| 28 | 3 | 11 | ii. *t*. |
| | 5 | 18 | i. *t*. |
| | 5 | 49 | ii. T. |
| | 7 | 34 | i. T. |

*March.*

| d | h | m | |
|---|---|---|---|
| 1 | 2 | 31 | i. *o*. |
| | 6 | 1 | i. E. |
| | 18 | 6 | iii. *t*. |
| | 21 | 0 | iii. T. |
| | 21 | 50 | ii. *o*. |
| | 23 | 46 | i. *t*. |
| 2 | 2 | 2 | i. T. |
| | 2 | 56 | ii. E. |
| | 20 | 59 | i. *o*. |
| 3 | 0 | 30 | i. E. |
| | 16 | 27 | ii. t. |
| | 18 | 14 | i. t. |

*Mar.* (con.).

| d | h | m | |
|---|---|---|---|
| 3 | 19 | 5 | ii. T. |
| | 20 | 30 | i. T. |
| 4 | 15 | 28 | i. *o*. |
| | 18 | 59 | i. E. |
| 5 | 7 | 53 | iii. *o*. |
| | 10 | 48 | iii. O. |
| | 11 | 6 | ii. *o*. |
| | 12 | 42 | i. *t*. |
| | 13 | 4 | iii. *e*. |
| | 14 | 59 | i. T. |
| | 15 | 58 | iii. E. |
| | 16 | 13 | ii. E. |
| 6 | 9 | 56 | i. *o*. |
| | 13 | 28 | i. E. |
| 7 | 5 | 45 | ii. *t*. |
| | 7 | 10 | i. *t*. |
| | 8 | 23 | ii. T. |
| | 9 | 27 | i. T. |
| | 19 | 23 | iv. *o*. |
| | 20 | 33 | iv. O. |
| 8 | 4 | 25 | i. *o*. |
| | 7 | 24 | iv. *e*. |
| | 7 | 57 | i. E. |
| | 9 | 18 | iv. E. |
| | 21 | 59 | iii. *t*. |
| 9 | 0 | 22 | ii. *o*. |
| | 0 | 54 | iii. T. |
| | 1 | 39 | i. *t*. |
| | 3 | 55 | i. T. |
| | 5 | 31 | ii. E. |
| | 22 | 53 | i. *o*. |
| 10 | 2 | 25 | i. E. |
| | 19 | 2 | ii. *t*. |
| | 20 | 7 | i. *t*. |
| | 21 | 40 | ii. T. |
| | 22 | 24 | i. T. |
| 11 | 17 | 22 | i. *o*. |
| | 20 | 54 | i. E. |
| 12 | 11 | 49 | iii. *o*. |
| | 13 | 38 | ii. *o*. |
| | 14 | 36 | i. *t*. |
| | 14 | 44 | iii. O. |
| | 16 | 52 | i. T. |
| | 17 | 5 | iii. *e*. |
| | 18 | 49 | ii. E. |
| | 19 | 59 | iii. E. |
| 13 | 11 | 51 | i. *o*. |
| | 15 | 23 | i. E. |
| 14 | 8 | 21 | ii. *t*. |
| | 9 | 4 | i. *t*. |
| | 10 | 59 | ii. T. |
| | 11 | 21 | i. T. |
| 15 | 6 | 19 | i. o. |
| | 9 | 52 | i. |

*Mar.* (con.).

| d | h | m | |
|---|---|---|---|
| 16 | 1 | 55 | iii. *t*. |
| | 2 | 55 | ii. *o*. |
| | 3 | 33 | i. *t*. |
| | 4 | 26 | iv. *t*. |
| | 4 | 51 | iii. T. |
| | 5 | 48 | iv. T. |
| | 5 | 50 | i. T. |
| | 8 | 7 | ii. E. |
| 17 | 0 | 48 | i. *o*. |
| | 4 | 21 | i. E. |
| | 21 | 39 | ii. *t*. |
| | 22 | 2 | i. *t*. |
| 18 | 0 | 18 | ii. T. |
| | 0 | 18 | i. T. |
| | 19 | 17 | i. *o*. |
| | 22 | 50 | i. E. |
| 19 | 15 | 48 | iii. *o*. |
| | 16 | 13 | ii. *o*. |
| | 16 | 30 | i. *t*. |
| | 18 | 44 | iii. O. |
| | 18 | 47 | i. T. |
| | 21 | 6 | iii. *e*. |
| | 21 | 24 | ii. E. |
| 20 | 0 | 2 | iii. E. |
| | 13 | 46 | i. *o*. |
| | 17 | 19 | i. E. |
| 21 | 10 | 59 | ii. *t*. |
| | 10 | 59 | i. *t*. |
| | 13 | 16 | i. T. |
| | 13 | 38 | ii. T. |
| 22 | 8 | 15 | i. *o*. |
| | 11 | 48 | i. E. |
| 23 | 5 | 28 | i. *t*. |
| | 5 | 30 | ii. *o*. |
| | 5 | 55 | iii. *t*. |
| | 7 | 45 | i. T. |
| | 8 | 52 | iii. T. |
| | 10 | 42 | ii. E. |
| 24 | 2 | 43 | i. *o*. |
| | 6 | 17 | i. E. |
| | 13 | 13 | iv. *o*. |
| | 14 | 47 | iv. O. |
| | 23 | 57 | i. *t*. |
| 25 | 0 | 18 | ii. *t*. |
| | 1 | 25 | iv. *e*. |
| | 2 | 14 | i. T. |
| | 2 | 57 | ii. T. |
| | 3 | 35 | iv. E. |
| | 21 | 13 | i. *o*. |
| 26 | 0 | 46 | i. E. |
| | 18 | 26 | i. *t*. |
| | 18 | 49 | ii. *o*. |
| | 19 | 51 | iii. *o*. |
| | 20 | 43 | i. T. |
| | 22 | 48 | iii. O. |
| 27 | 0 | 0 | ii. E. |
| | 1 | 6 | iii. *e*. |
| | 4 | 3 | iii. E. |
| | 15 | 42 | i. *o*. |
| | 19 | 15 | i. E. |
| 28 | 12 | 55 | i. *t*. |
| | 13 | 38 | ii. *t*. |
| | 15 | 12 | i. T. |
| | 16 | 18 | ii. T. |

*Mar.* (con.).

| d | h | m | |
|---|---|---|---|
| 29 | 10 | 12 | i. *o*. |
| | 13 | 44 | i. E. |
| 30 | 7 | 24 | i. *t*. |
| | 8 | 8 | ii. *o*. |
| | 9 | 41 | i. T. |
| | 10 | 0 | iii. *t*. |
| | 12 | 58 | iii. T. |
| | 13 | 18 | ii. E. |
| 31 | 4 | 41 | i. *o*. |
| | 8 | 13 | i. E. |

*April.*

| d | h | m | |
|---|---|---|---|
| 1 | 1 | 53 | i. *t*. |
| | 2 | 58 | ii. *t*. |
| | 4 | 10 | i. T. |
| | 5 | 38 | ii. T. |
| | 22 | 40 | iv. *t*. |
| | 23 | 10 | i. *o*. |
| 2 | 0 | 23 | iv. T. |
| | 2 | 42 | i. E. |
| | 20 | 23 | i. *t*. |
| | 21 | 27 | ii. *o*. |
| | 22 | 40 | i. T. |
| | 23 | 58 | iii. *o*. |
| 3 | 2 | 35 | ii. E. |
| | 2 | 56 | iii. O. |
| | 5 | 6 | iii. *e*. |
| | 8 | 4 | iii. E. |
| | 17 | 40 | i. *o*. |
| | 21 | 11 | i. E. |
| 4 | 14 | 52 | i. *t*. |
| | 16 | 20 | ii. *t*. |
| | 17 | 9 | i. T. |
| | 18 | 59 | ii. T. |
| 5 | 12 | 9 | i. *o*. |
| | 15 | 39 | i. E. |
| 6 | 9 | 21 | i. *t*. |
| | 10 | 47 | ii. *o*. |
| | 11 | 38 | i. T. |
| | 14 | 8 | iii. *t*. |
| | 15 | 53 | ii. E. |
| | 17 | 7 | iii. T. |
| 7 | 6 | 39 | i. *o*. |
| | 10 | 8 | i. E. |
| 8 | 3 | 51 | i. *t*. |
| | 5 | 41 | ii. *t*. |
| | 6 | 8 | i. T. |
| | 8 | 20 | ii. T. |
| 9 | 1 | 8 | i. *o*. |
| | 4 | 37 | i. E. |
| | 22 | 20 | i. *t*. |
| 10 | 0 | 7 | ii. *o*. |
| | 0 | 37 | i. T. |
| | 4 | 7 | iii. *o*. |
| | 5 | 11 | ii. E. |
| | 7 | 7 | iii. O. |
| | 7 | 55 | iv. *o*. |
| | 9 | 6 | iii. *e*. |
| | 9 | 48 | iv. O. |
| | 12 | 6 | iii. E. |
| | 19 | 28 | iv. *e*. |
| | 19 | 38 | i. *o*. |
| | 21 | 52 | iv. E. |

*Apr.* (con.).

| d | h | m | |
|---|---|---|---|
| 10 | 23 | 6 | i. E. |
| 11 | 16 | 50 | i. *t*. |
| | 19 | 3 | ii. *t*. |
| | 19 | 7 | i. T. |
| | 21 | 43 | ii. T. |
| 12 | 14 | 8 | i. *o*. |
| | 17 | 35 | i. E. |
| 13 | 11 | 19 | i. *t*. |
| | 13 | 27 | ii. *o*. |
| | 13 | 36 | i. T. |
| | 18 | 20 | iii. *t*. |
| | 18 | 29 | ii. E. |
| | 21 | 20 | iii. T. |
| 14 | 8 | 37 | i. *o*. |
| | 12 | 4 | i. E. |
| 15 | 5 | 49 | i. *t*. |
| | 8 | 6 | i. T. |
| | 8 | 25 | ii. *t*. |
| | 11 | 5 | ii. T. |
| 16 | 3 | 7 | i. *o*. |
| | 6 | 33 | i. E. |
| 17 | 0 | 18 | i. *t*. |
| | 2 | 35 | i. T. |
| | 2 | 48 | ii. *o*. |
| | 7 | 46 | ii. E. |
| | 8 | 20 | iii. *o*. |
| | 11 | 21 | iii. O. |
| | 13 | 6 | iii. *e*. |
| | 16 | 7 | iii. E. |
| | 21 | 37 | i. *o*. |
| 18 | 1 | 2 | i. E. |
| | 17 | 39 | iv. *t*. |
| | 18 | 48 | i. *t*. |
| | 19 | 41 | iv. T. |
| | 21 | 5 | i. T. |
| | 21 | 47 | ii. *t*. |
| 19 | 0 | 27 | ii. T. |
| | 16 | 6 | i. *o*. |
| | 19 | 31 | i. E. |
| 20 | 13 | 17 | i. *t*. |
| | 15 | 35 | i. T. |
| | 16 | 9 | ii. *o*. |
| | 21 | 4 | ii. E. |
| | 22 | 33 | iii. *t*. |
| 21 | 1 | 35 | iii. T. |
| | 10 | 36 | i. *o*. |
| | 14 | 0 | i. E. |
| 22 | 7 | 47 | i. *t*. |
| | 10 | 4 | i. T. |
| | 11 | 9 | ii. *t*. |
| | 13 | 50 | ii. T. |
| 23 | 5 | 6 | i. *o*. |
| | 8 | 28 | i. E. |
| 24 | 2 | 17 | i. *t*. |
| | 4 | 34 | i. T. |
| | 5 | 30 | ii. *o*. |
| | 10 | 22 | ii. E. |
| | 12 | 36 | iii. *o*. |
| | 15 | 38 | iii. O. |
| | 17 | 7 | iii. *e*. |
| | 20 | 8 | iii. E. |
| | 23 | 36 | i. *o*. |
| 25 | 2 | 57 | i. E. |
| | 20 | 47 | i. *t*. |

*Apr.* (con.).

| d | h | m | |
|---|---|---|---|
| 25 | 23 | 4 | i. T. |
| 26 | 0 | 32 | ii. *t*. |
| | 3 | 13 | ii. T. |
| | 18 | 6 | i. *o*. |
| | 21 | 26 | i. E. |
| 27 | 3 | 18 | iv. *o*. |
| | 5 | 29 | iv. O. |
| | 13 | 30 | iv. *e*. |
| | 15 | 17 | i. *t*. |
| | 16 | 7 | iv. E. |
| | 17 | 34 | i. T. |
| | 18 | 52 | ii. *o*. |
| | 23 | 40 | ii. E. |
| 28 | 2 | 50 | iii. *t*. |
| | 5 | 53 | iii. T. |
| | 12 | 36 | i. *o*. |
| | 15 | 55 | i. E. |
| 29 | 9 | 46 | i. *t*. |
| | 12 | 4 | i. T. |
| | 13 | 55 | ii. *t*. |
| | 16 | 36 | ii. T. |
| 30 | 7 | 6 | i. *o*. |
| | 10 | 24 | i. E. |

*May.*

| d | h | m | |
|---|---|---|---|
| 1 | 4 | 16 | i. *t*. |
| | 6 | 34 | i. T. |
| | 8 | 14 | ii. *o*. |
| | 12 | 58 | ii. E. |
| | 16 | 55 | iii. *o*. |
| | 19 | 58 | iii. O. |
| | 21 | 7 | iii. *e*. |
| 2 | 0 | 10 | iii. E. |
| | 1 | 36 | i. *o*. |
| | 4 | 53 | i. E. |
| | 22 | 46 | i. *t*. |
| 3 | 1 | 3 | i. T. |
| | 3 | 19 | ii. *t*. |
| | 6 | 0 | ii. T. |
| | 20 | 6 | i. *o*. |
| | 23 | 22 | i. E. |
| 4 | 17 | 16 | i. *t*. |
| | 19 | 33 | i. T. |
| | 21 | 37 | ii. *o*. |
| 5 | 2 | 16 | ii. E. |
| | 7 | 9 | iii. *t*. |
| | 10 | 13 | iii. T. |
| | 13 | 16 | iv. *t*. |
| | 14 | 36 | i. *o*. |
| | 15 | 34 | iv. T. |
| | 17 | 50 | i. E. |
| 6 | 11 | 46 | i. *t*. |
| | 14 | 4 | i. T. |
| | 16 | 42 | ii. *t*. |
| | 19 | 23 | ii. T. |
| 7 | 9 | 6 | i. *o*. |
| | 12 | 19 | i. E. |
| 8 | 6 | 16 | i. *t*. |
| | 8 | 34 | i. T. |
| | 10 | 59 | ii. *o*. |
| | 15 | 34 | ii. E. |
| | 21 | 15 | iii. *o*. |
| 9 | 0 | 20 | iii. O. |
| | 1 | 8 | iii. *e*. |

*May* (con.).

| d | h | m | |
|---|---|---|---|
| 9 | 3 | 36 | i. *o*. |
| | 4 | 11 | iii. E. |
| | 6 | 48 | i. E. |
| 10 | 0 | 46 | i. *t*. |
| | 3 | 4 | i. T. |
| | 6 | 6 | ii. *t*. |
| | 8 | 48 | ii. T. |
| | 22 | 6 | i. *o*. |
| 11 | 1 | 17 | i. E. |
| | 19 | 16 | i. *t*. |
| | 21 | 34 | i. T. |
| 12 | 0 | 22 | ii. *o*. |
| | 4 | 51 | ii. E. |
| | 11 | 29 | iii. *t*. |
| | 14 | 35 | iii. T. |
| | 16 | 37 | i. *o*. |
| | 19 | 46 | i. E. |
| 13 | 13 | 46 | i. *t*. |
| | 16 | 4 | i. T. |
| | 19 | 29 | ii. *t*. |
| | 22 | 11 | ii. T. |
| | 23 | 12 | iv. *o*. |
| 14 | 1 | 39 | iv. O. |
| | 7 | 33 | iv. *e*. |
| | 10 | 21 | iv. E. |
| | 11 | 7 | i. *o*. |
| | 14 | 15 | i. E. |
| 15 | 8 | 16 | i. *t*. |
| | 10 | 34 | i. T. |
| | 13 | 45 | ii. *o*. |
| | 18 | 9 | ii. E. |
| 16 | 1 | 38 | iii. *o*. |
| | 4 | 44 | iii. O. |
| | 5 | 7 | iii. *e*. |
| | 5 | 37 | i. *o*. |
| | 8 | 12 | iii. E. |
| | 8 | 43 | i. E. |
| 17 | 2 | 46 | i. *t*. |
| | 5 | 4 | i. T. |
| | 8 | 54 | ii. *t*. |
| | 11 | 36 | ii. T. |
| 18 | 0 | 7 | i. *o*. |
| | 3 | 12 | i. E. |
| | 21 | 17 | i. *t*. |
| | 23 | 34 | i. T. |
| 19 | 3 | 9 | ii. *o*. |
| | 7 | 27 | ii. E. |
| | 15 | 52 | iii. *t*. |
| | 18 | 37 | i. *o*. |
| | 18 | 59 | iii. T. |
| | 21 | 41 | i. E. |
| 20 | 15 | 47 | i. *t*. |
| | 18 | 4 | i. T. |
| | 22 | 17 | ii. *t*. |
| 21 | 1 | 0 | ii. T. |
| | 13 | 8 | i. *o*. |
| | 16 | 10 | i. E. |
| 22 | 9 | 18 | iv. *t*. |
| | 10 | 17 | i. *t*. |
| | 11 | 54 | iv. T. |
| | 12 | 35 | i. T. |
| | 16 | 32 | ii. *o*. |
| | 20 | 45 | ii. E. |
| 23 | 6 | 1 | iii. *o*. |

*Ma*

| d | h |
|---|---|
| 23 | 7 |
| | 10 |
| | 12 |
| 24 | 4 |
| | 7 |
| | 11 |
| | 14 |
| 25 | 2 |
| | 5 |
| | 23 |
| 26 | 1 |
| | 5 |
| | 10 |
| | 20 |
| | 20 |
| | 23 |
| | 23 |
| 27 | 17 |
| | 20 |
| 28 | 1 |
| | 3 |
| | 15 |
| | 18 |
| 29 | 12 |
| | 14 |
| | 19 |
| | 23 |
| 30 | 9 |
| | 10 |
| | 12 |
| | 16 |
| | 19 |
| | 22 |
| 31 | 1 |
| | 4 |
| | 6 |
| | 9 |
| | 14 |
| | 17 |
| 1 | 4 |
| | 7 |
| 2 | 1 |
| | 3 |
| | 8 |
| | 12 |
| | 22 |
| 3 | 0 |
| | 1 |
| | 3 |
| | 19 |
| | 22 |
| 4 | 3 |
| | 6 |
| | 17 |
| | 20 |
| 5 | 14 |
| | 16 |
| | 22 |
| 6 | 1 |
| | 11 |
| | 14 |
| | 14 |

*June* (con.).

| d | h | m | |
|---|---|---|---|
| 6 | 20 | 13 | iii. E. |
| 7 | 8 | 49 | i. *t*. |
| | 11 | 7 | i. T. |
| | 17 | 21 | ii. *t*. |
| | 20 | 5 | ii. T. |
| 8 | 5 | 39 | iv. *t*. |
| | 6 | 11 | i. *o*. |
| | 8 | 31 | iv. T. |
| | 8 | 57 | i. E. |
| 9 | 3 | 20 | i. *t*. |
| | 5 | 38 | i. T. |
| | 11 | 32 | ii. *o*. |
| | 15 | 15 | ii. E. |
| 10 | 0 | 41 | i. *o*. |
| | 3 | 26 | i. E. |
| | 5 | 8 | iii. *t*. |
| | 8 | 20 | iii. T. |
| | 21 | 50 | i. *t*. |
| 11 | 0 | 8 | i. T. |
| | 6 | 45 | ii. *t*. |
| | 9 | 30 | ii. T. |
| | 19 | 11 | i. *o*. |
| | 21 | 55 | i. E. |

*August.*

| d | h | m | |
|---|---|---|---|
| 8 | 8 | 31 | i. *t*. |
| | 10 | 50 | i. T. |
| | 22 | 39 | ii. *e*. |
| 9 | 2 | 27 | ii. O. |
| | 5 | 24 | i. *e*. |
| | 8 | 10 | i. O. |
| 10 | 3 | 1 | i. *t*. |
| | 4 | 58 | iii. *e*. |
| | 5 | 20 | i. *t*. |
| | 10 | 23 | iii. O. |
| | 18 | 44 | ii. *t*. |
| | 21 | 34 | ii. T. |
| | 23 | 52 | i. *e*. |
| 11 | 2 | 41 | i. O. |
| | 21 | 31 | i. *t*. |
| | 23 | 51 | i. T. |
| 12 | 11 | 57 | ii. *e*. |
| | 15 | 52 | ii. O. |
| | 18 | 21 | i. *e*. |
| | 21 | 11 | i. O. |
| 13 | 16 | 2 | i. *t*. |
| | 18 | 21 | i. T. |
| | 21 | 13 | iii. *t*. |
| 14 | 0 | 39 | iii. T. |
| | 8 | 8 | ii. *t*. |
| | 10 | 58 | ii. T. |
| | 12 | 49 | i. *e*. |
| | 15 | 41 | i. O. |
| | 15 | 54 | iv. *t*. |
| | 19 | 46 | iv. T. |
| 15 | 10 | 32 | i. *t*. |
| | 12 | 51 | i. T. |
| 16 | 1 | 15 | ii. *e*. |
| | 5 | 17 | ii. O. |
| | 7 | 17 | i. *e*. |
| | 10 | 11 | i. O. |
| 17 | 5 | 2 | i. *t*. |
| | 7 | 21 | i. T. |

*Aug.* (con.).

| d | h | m | |
|---|---|---|---|
| 17 | 8 | 57 | iii. *e*. |
| | 14 | 50 | iii. O. |
| | 21 | 31 | ii. *t*. |
| 18 | 0 | 22 | ii T. |
| | 1 | 46 | i. *e*. |
| | 4 | 41 | i. O. |
| | 23 | 32 | i. *t*. |
| 19 | 1 | 51 | i. T. |
| | 14 | 33 | ii *e*. |
| | 18 | 42 | ii. O. |
| | 20 | 14 | i. *e*. |
| | 23 | 11 | i. O. |
| 20 | 18 | 2 | i. *t*. |
| | 20 | 22 | i. T. |
| 21 | 1 | 37 | iii. *t*. |
| | 5 | 5 | iii. T. |
| | 10 | 55 | ii. *t*. |
| | 13 | 46 | ii. T. |
| | 14 | 43 | i. *e*. |
| | 17 | 41 | i. O. |
| 22 | 12 | 32 | i. *t*. |
| | 14 | 52 | i. T. |
| | 19 | 43 | iv. *e*. |
| | 23 | 25 | iv. E. |
| 23 | 2 | 21 | iv. *o*. |
| | 3 | 51 | ii. *e*. |
| | 6 | 20 | iv. O. |
| | 8 | 7 | ii. O. |
| | 9 | 11 | i. *e*. |
| | 12 | 11 | i. O. |
| 24 | 7 | 2 | i. *t*. |
| | 9 | 22 | i. T. |
| | 12 | 55 | iii. *e*. |
| | 19 | 15 | iii. O. |
| 25 | 0 | 18 | ii. *t*. |
| | 3 | 9 | ii. T. |
| | 3 | 39 | i. *e*. |
| | 6 | 41 | i. O. |
| 26 | 1 | 32 | i. *t*. |
| | 3 | 52 | i. T. |
| | 17 | 9 | ii. *e*. |
| | 21 | 32 | ii. O. |
| | 22 | 8 | i. *e*. |
| 27 | 1 | 11 | i. O. |
| | 20 | 2 | i. *t*. |
| | 22 | 22 | i. T. |
| 28 | 6 | 0 | iii. *t*. |
| | 9 | 30 | iii. T. |
| | 13 | 41 | ii. *t*. |
| | 16 | 33 | ii. T. |
| | 16 | 36 | i. *e*. |
| | 19 | 41 | i. O. |
| 29 | 14 | 33 | i. *t*. |
| | 16 | 52 | i. T. |
| 30 | 6 | 28 | ii. *e*. |
| | 10 | 56 | ii. O. |
| | 11 | 5 | i. *e*. |
| | 14 | 11 | i. O. |
| 31 | 9 | 3 | i. *t*. |
| | 11 | 22 | i. T. |
| | 12 | 8 | iv. *t*. |
| | 16 | 13 | iv T. |
| | *16* | *53* | *iii. e.* |

*Aug.* (con.).

| d | h | m | |
|---|---|---|---|
| 31 | 23 | 39 | iii. O. |

*September.*

| d | h | m | |
|---|---|---|---|
| 1 | 3 | 4 | ii. *t*. |
| | 5 | 33 | i. *e*. |
| | 5 | 56 | ii. T. |
| | 8 | 40 | i. O. |
| 2 | 3 | 32 | i. *t*. |
| | 5 | 52 | i. T. |
| | 19 | 45 | ii. *e*. |
| 3 | 0 | 1 | i. *e*. |
| | 0 | 21 | ii. O. |
| | 3 | 10 | i. O. |
| | 22 | 2 | i. *t*. |
| 4 | 0 | 22 | i. T. |
| | 10 | 22 | iii. *t*. |
| | 13 | 52 | iii. T. |
| | 16 | 27 | ii. *t*. |
| | 18 | 30 | i. *e*. |
| | 19 | 19 | ii. T. |
| | 21 | 40 | i. O. |
| 5 | 16 | 32 | i. *t*. |
| | 18 | 51 | i. T. |
| 6 | 9 | 4 | ii. *e*. |
| | 12 | 58 | i. *e*. |
| | 13 | 45 | ii. O. |
| | 16 | 10 | i. O. |
| 7 | 11 | 2 | i. *t*. |
| | 13 | 21 | i. T. |
| | 20 | 51 | iii. *e*. |
| 8 | 0 | 9 | iii. E. |
| | 0 | 29 | iii. *o*. |
| | 4 | 0 | iii. O. |
| | 5 | 49 | ii. *t*. |
| | 7 | 26 | i. *e*. |
| | 8 | 41 | ii. T. |
| | 10 | 39 | i. O. |
| | 13 | 43 | iv. *e*. |
| | 17 | 32 | iv. E. |
| | 22 | 30 | iv. *o*. |
| 9 | 2 | 40 | iv. O. |
| | 5 | 32 | i. *t*. |
| | 7 | 51 | i. T. |
| | 22 | 22 | ii. *e*. |
| 10 | 1 | 55 | i. *e*. |
| | 3 | 8 | ii. O. |
| | 5 | 9 | i. O. |
| 11 | 0 | 1 | i. *t*. |
| | 2 | 21 | i. T. |
| | 14 | 43 | iii. *t*. |
| | 18 | 14 | iii. T. |
| | 19 | 11 | ii. *t*. |
| | 20 | 23 | i. *e*. |
| | 22 | 3 | ii. T. |
| | 23 | 38 | i. O. |
| 12 | 18 | 31 | i. *t*. |
| | 20 | 51 | i. T. |
| 13 | 11 | 40 | ii. *e*. |
| | 14 | 51 | i. *e*. |
| | 16 | 32 | ii. O. |
| | 18 | 8 | i. O. |
| *14* | *13* | *1* | *i. t.* |
| | *15* | *20* | *i. T.* |

*Sept.* (con.).

| d | h | m | |
|---|---|---|---|
| 15 | 0 | 49 | iii. *e*. |
| | 4 | 8 | iii. E. |
| | 4 | 47 | iii. *o*. |
| | 8 | 20 | iii. O. |
| | 8 | 33 | ii. *t*. |
| | 9 | 20 | i. *e*. |
| | 11 | 25 | ii. T. |
| | 12 | 37 | i. O. |
| 16 | 7 | 30 | i. *t*. |
| | 9 | 50 | i. T. |
| 17 | 0 | 58 | ii. *e*. |
| | 3 | 48 | i. *e*. |
| | 5 | 55 | ii. O. |
| | 7 | 7 | i. O. |
| | 8 | 1 | iv. *t*. |
| | 12 | 16 | iv. T. |
| 18 | 2 | 0 | i. *t*. |
| | 4 | 20 | i. T. |
| | 19 | 0 | iii. *t*. |
| | 21 | 54 | ii. *t*. |
| | 22 | 16 | i. *e*. |
| | 22 | 33 | iii. T. |
| 19 | 0 | 47 | ii. T. |
| | 1 | 36 | i. O. |
| | 20 | 30 | i. *t*. |
| | 22 | 49 | i. T. |
| 20 | 14 | 17 | ii. *e*. |
| | 16 | 45 | i. *e*. |
| | 19 | 18 | ii. O. |
| | 20 | 6 | i. O. |
| 21 | 14 | 59 | i. *t*. |
| | 17 | 19 | i. T. |
| 22 | 4 | 47 | iii. *e*. |
| | 8 | 7 | iii. E. |
| | 9 | 4 | iii. *o*. |
| | 11 | 13 | i. *e*. |
| | 11 | 15 | ii. *t*. |
| | 12 | 37 | iii. O. |
| | 14 | 8 | ii. T. |
| | 14 | 35 | i. O. |
| 23 | 9 | 29 | i. *t*. |
| | 11 | 48 | i. T. |
| 24 | 3 | 34 | ii. *e*. |
| | 5 | 41 | i. *e*. |
| | 8 | 41 | ii. O. |
| | 9 | 5 | i. O. |
| 25 | 3 | 58 | i. *t*. |
| | 6 | 18 | i. T. |
| | 7 | 43 | iv. *e*. |
| | 11 | 39 | iv. E. |
| | 18 | 14 | iv. *o*. |
| | 22 | 33 | iv. O. |
| | 23 | 16 | iii. *t*. |
| 26 | 0 | 10 | i. *e*. |
| | 0 | 36 | ii. *t*. |
| | 2 | 49 | iii. T. |
| | 3 | 29 | ii. T. |
| | 3 | 34 | i. O. |
| | 22 | 28 | i. *t*. |
| 27 | 0 | 47 | i. T. |
| | 16 | 53 | ii. *e*. |
| | 18 | 38 | i. *e*. |
| | 22 | 3 | ii. O. |
| | 22 | 3 | i. O. |

*Sept.* (con.).

| d | h | m | |
|---|---|---|---|
| 28 | 16 | 57 | i. *t*. |
| | 19 | 17 | i. T. |
| 29 | 8 | 45 | iii. *e*. |
| | 12 | 6 | iii. E. |
| | 13 | 6 | i. *e*. |
| | 13 | 18 | iii. *o*. |
| | 13 | 57 | ii. *t*. |
| | 16 | 33 | i. O. |
| | 16 | 50 | ii. T. |
| | 16 | 52 | iii. O. |
| 30 | 11 | 26 | i. T. |
| | 13 | 46 | i. *t*. |

*October.*

| d | h | m | |
|---|---|---|---|
| 1 | 6 | 11 | ii. *e*. |
| | 7 | 35 | i. *e*. |
| | 11 | 2 | i. O. |
| | 11 | 25 | ii. O. |
| 2 | 5 | 56 | i. *t*. |
| | 8 | 16 | i. T. |
| 3 | 2 | 3 | i. *e*. |
| | 3 | 17 | ii. *t*. |
| | 3 | 28 | iii. *t*. |
| | 5 | 31 | i. O. |
| | 6 | 10 | ii. T. |
| | 7 | 3 | iii. T. |
| 4 | 0 | 25 | i. *t*. |
| | 2 | 45 | i. T. |
| | 3 | 26 | iv. *t*. |
| | 7 | 49 | iv. T. |
| | 19 | 29 | ii. *e*. |
| | 20 | 31 | i. *e*. |
| 5 | 0 | 0 | i. O. |
| | 0 | 47 | ii. O. |
| | 18 | 54 | i. *t*. |
| | 21 | 14 | i. T. |
| 6 | 12 | 44 | iii. *e*. |
| | 14 | 59 | i. *e*. |
| | 16 | 5 | iii. E. |
| | 16 | 37 | ii. *t*. |
| | 17 | 29 | iii. *o*. |
| | 18 | 29 | i. O. |
| | 19 | 30 | ii. T. |
| | 21 | 5 | iii. O. |
| 7 | 13 | 23 | i. *t*. |
| | 15 | 43 | i. T. |
| 8 | 8 | 47 | ii. *e*. |
| | 9 | 28 | i. *e*. |
| | 12 | 58 | i. O. |
| | 14 | 8 | ii. O. |
| 9 | 7 | 53 | i. *t*. |
| | 10 | 12 | i. T. |
| 10 | 3 | 56 | i. *e*. |
| | 5 | 56 | ii. *t*. |
| | 7 | 27 | i. O. |
| | 7 | 38 | iii. *t*. |
| | 8 | 50 | ii. T. |
| | 11 | 13 | iii. T. |
| 11 | 2 | 21 | i. *t*. |
| | 4 | 41 | i. T. |
| | 22 | 5 | ii. *e*. |
| | 22 | 24 | i. *e*. |
| 12 | 1 | 43 | iv. *e*. |
| | 1 | 56 | i. O. |

*Oct.* (con.).

| d | h | m | |
|---|---|---|---|
| 12 | 3 | 29 | ii. O. |
| | 5 | 44 | iv. E. |
| | 13 | 23 | iv. *o*. |
| | 17 | 50 | iv. O. |
| | 20 | 51 | i. *t*. |
| | 23 | 10 | i. T. |
| 13 | 16 | 41 | iii. *e*. |
| | 16 | 52 | i. *e*. |
| | 19 | 15 | ii. *t*. |
| | 20 | 3 | iii. E. |
| | 20 | 25 | i. O. |
| | 21 | 37 | iii. *o*. |
| | 22 | 9 | ii. T. |
| 14 | 1 | 13 | iii. O. |
| | 15 | 19 | i. *t*. |
| | 17 | 39 | i. T. |
| 15 | 11 | 21 | i. *e*. |
| | 11 | 23 | ii. *e*. |
| | 14 | 53 | i. O. |
| | 16 | 49 | ii. O. |
| 16 | 9 | 48 | i. *t*. |
| | 12 | 8 | i. T. |
| 17 | 5 | 49 | i. *e*. |
| | 8 | 34 | ii. *t*. |
| | 9 | 22 | i. O. |
| | 11 | 28 | ii. T. |
| | 11 | 44 | iii. *t*. |
| | 15 | 21 | iii. T. |
| 18 | 4 | 17 | i. *t*. |
| | 6 | 37 | i. T. |
| 19 | 0 | 17 | i. *e*. |
| | 0 | 42 | ii. *e*. |
| | 3 | 51 | i. O. |
| | 6 | 9 | ii. O. |
| | 22 | 46 | i. *t*. |
| 20 | 1 | 6 | i. T. |
| | 18 | 46 | i. *e*. |
| | 20 | 39 | iii. *e*. |
| | 21 | 52 | ii. *t*. |
| | 22 | 11 | iv. *t*. |
| | 22 | 19 | i. O. |
| 21 | 0 | 1 | iii. E. |
| | 0 | 46 | ii. T. |
| | 1 | 41 | iii. *o*. |
| | 2 | 42 | iv. T. |
| | 5 | 18 | iii. O. |
| | 17 | 15 | i. *t*. |
| | 19 | 35 | i. T. |
| 22 | 13 | 14 | i. *e*. |
| | 13 | 59 | ii. *e*. |
| | 16 | 48 | i. O. |
| | 19 | 29 | ii. O. |
| 23 | 11 | 43 | i. *t*. |
| | 14 | 3 | i. T. |
| 24 | 7 | 42 | i. *e*. |
| | 11 | 9 | ii. *t*. |
| | 11 | 17 | i. O. |
| | 14 | 4 | ii. T. |
| | 15 | 47 | iii. *t*. |
| | 19 | 25 | iii. T. |
| 25 | 6 | 12 | i. *t*. |
| | 8 | 32 | i. T. |
| 26 | 2 | 10 | i. *e*. |
| | 3 | 18 | ii. |

*Oct.* (con.).

| d | h | m | |
|---|---|---|---|
| 26 | 5 | 45 | i. O. |
| | 8 | 48 | ii. O. |
| 27 | 0 | 41 | i. *t*. |
| | 3 | 1 | i. T. |
| | 20 | 39 | i. *e*. |
| 28 | 0 | 13 | i. O. |
| | 0 | 26 | ii. *t*. |
| | 0 | 36 | iii. *e*. |
| | 3 | 21 | ii. T. |
| | 3 | 59 | iii. E. |
| | 5 | 42 | iii. *o*. |
| | 9 | 19 | iii. O. |
| | 19 | 9 | i. *t*. |
| | 19 | 43 | iv. *e*. |
| | 21 | 29 | i. T. |
| | 23 | 50 | iv. E. |
| 29 | 7 | 50 | iv. *o*. |
| | 12 | 24 | iv. O. |
| | 15 | 7 | i. *e*. |
| | 16 | 35 | ii. *e*. |
| | 18 | 42 | i. O. |
| | 22 | 6 | ii. O. |
| 30 | 13 | 37 | i. *t*. |
| | 15 | 57 | i. T. |
| 31 | 9 | 35 | i. *e*. |
| | 13 | 10 | i. O. |
| | 13 | 43 | ii. *t*. |
| | 16 | 37 | ii. T. |
| | 19 | 47 | iii. *t*. |
| | 23 | 25 | iii. T. |

*November.*

| d | h | m | |
|---|---|---|---|
| 1 | 8 | 6 | i. *t*. |
| | 10 | 26 | i. T. |
| 2 | 4 | 3 | i. *e*. |
| | 5 | 54 | ii. *e*. |
| | 7 | 38 | i. O. |
| | 11 | 24 | ii. O. |
| 3 | 2 | 34 | i. *t*. |
| | 4 | 54 | i. T. |
| | 22 | 32 | i. *e*. |
| 4 | 2 | 6 | i. O. |
| | 2 | 59 | ii. *t*. |
| | 4 | 34 | iii. *e*. |
| | 5 | 53 | ii. T. |
| | 7 | 58 | iii. E. |
| | 9 | 38 | iii. *o*. |
| | 13 | 16 | iii. O. |
| | 21 | 2 | i. *t*. |
| | 23 | 22 | i. T. |
| 5 | 17 | 0 | i. *e*. |

*Nov.* (con.).

| d | h | m | |
|---|---|---|---|
| 5 | 19 | 12 | ii. *e*. |
| | 20 | 34 | i. O. |
| 6 | 0 | 41 | ii. O. |
| | 15 | 31 | i. *t*. |
| | 16 | 8 | iv. *t*. |
| | 17 | 51 | i. T. |
| | 20 | 45 | iv. T. |
| 7 | 11 | 28 | i. *e*. |
| | 15 | 2 | i. O. |
| | 16 | 14 | ii. *t*. |
| | 19 | 9 | ii. T. |
| | 23 | 41 | iii. *t*. |
| 8 | 3 | 20 | iii. T. |
| | 9 | 59 | i. *t*. |
| | 12 | 19 | i. T. |
| 9 | 5 | 56 | i. *e*. |
| | 8 | 30 | ii. *e*. |
| | 9 | 30 | i. O. |
| | 13 | 58 | ii. O. |
| 10 | 4 | 27 | i. *t*. |
| | 6 | 47 | i. T. |
| 11 | 0 | 25 | i. *e*. |
| | 3 | 58 | i. O. |
| | 5 | 29 | ii. *t*. |
| | 8 | 24 | ii. T. |
| | 8 | 32 | iii. *e*. |
| | 11 | 56 | iii. E. |
| | 13 | 31 | iii. *o*. |
| | 17 | 9 | iii. O. |
| | 22 | 55 | i. *t*. |
| 12 | 1 | 15 | i. T. |
| | 18 | 53 | i. *e*. |
| | 21 | 48 | ii. *e*. |
| | 22 | 26 | i. O. |
| 13 | 3 | 14 | ii. O. |
| | 17 | 23 | i. *t*. |
| | 19 | 43 | i. T. |
| 14 | 13 | 21 | i. *e*. |
| | 13 | 42 | iv. *e*. |
| | 16 | 54 | i. O. |
| | 17 | 54 | iv. E. |
| | 18 | 44 | ii. *t*. |
| | 21 | 39 | ii. T. |
| 15 | 1 | 23 | iv. *o*. |
| | 3 | 32 | iii. *t*. |
| | 6 | 2 | iv. O. |
| | 7 | 11 | iii. T. |
| | 11 | 51 | i. *t*. |
| | 14 | 11 | i. T. |
| 16 | 7 | 49 | i. *e*. |
| | 11 | 6 | ii. *e*. |

*Nov.* (con.).

| d | h | m | |
|---|---|---|---|
| 16 | 11 | 21 | i. O. |
| | 16 | 30 | ii. O. |
| 17 | 6 | 18 | i. *t*. |
| | 8 | 38 | i. T. |
| 18 | 2 | 18 | i. *e*. |
| | 5 | 49 | i. O. |
| | 7 | 57 | ii. *t*. |
| | 10 | 52 | ii. T. |
| | 12 | 30 | iii. *e*. |
| | 15 | 55 | iii. E. |
| | 17 | 19 | iii. *o*. |
| | 20 | 58 | iii. O. |
| 19 | 0 | 46 | i. *t*. |
| | 3 | 6 | i. T. |
| | 20 | 46 | i. *e*. |
| 20 | 0 | 16 | i. O. |
| | 0 | 24 | ii. *e*. |
| | 5 | 45 | ii. O. |
| | 19 | 13 | i. *t*. |
| | 21 | 33 | i. T. |
| 21 | 15 | 14 | i. *e*. |
| | 18 | 44 | i. O. |
| | 21 | 11 | ii. *t*. |
| 22 | 0 | 6 | ii. T. |
| | 7 | 17 | iii. *t*. |
| | 10 | 57 | iii. T. |
| | 13 | 41 | i. *t*. |
| | 16 | 1 | i. T. |
| 23 | 9 | 10 | iv. *t*. |
| | 9 | 43 | i. *e*. |
| | 13 | 11 | i. O. |
| | 13 | 42 | ii. *e*. |
| | 13 | 51 | iv. T. |
| | 18 | 59 | ii. O. |
| 24 | 8 | 9 | i. *t*. |
| | 10 | 29 | i. T. |
| 25 | 4 | 11 | i. *e*. |
| | 7 | 39 | i. O. |
| | 10 | 24 | ii. *t*. |
| | 13 | 20 | ii. T. |
| | 16 | 28 | iii. *e*. |
| | 19 | 54 | iii. E. |
| | 21 | 2 | iii. *o*. |
| 26 | 0 | 42 | iii. O. |
| | 2 | 36 | i. *t*. |
| | 4 | 57 | i. T. |
| | 22 | 39 | i. *e*. |
| 27 | 2 | 6 | i. O. |
| | 3 | 0 | ii. *e*. |
| | 8 | 13 | ii. O. |
| | 21 | 3 | i. *t*. |

*Nov.* (con.).

| d | h | m | |
|---|---|---|---|
| 27 | 23 | 23 | i. T. |
| 28 | 17 | 7 | i. *e*. |
| | 20 | 33 | i. O. |
| | 23 | 36 | ii. *t*. |
| 29 | 2 | 31 | ii. T. |
| | 10 | 58 | iii. *t*. |
| | 14 | 38 | iii. T. |
| | 15 | 31 | i. *t*. |
| | 17 | 51 | i. T. |
| 30 | 11 | 36 | i. *e*. |
| | 15 | 0 | i. O. |
| | 16 | 18 | ii. *e*. |
| | 21 | 26 | ii. O. |

*December.*

| d | h | m | |
|---|---|---|---|
| 1 | 7 | 41 | iv. *e*. |
| | 9 | 58 | i. *t*. |
| | 11 | 58 | iv. E. |
| | 12 | 18 | i. T. |
| | 17 | 58 | iv. *o*. |
| | 22 | 39 | iv. O. |
| 2 | 6 | 4 | i. *e*. |
| | 9 | 27 | i. O. |
| | 12 | 47 | ii. *t*. |
| | 15 | 42 | ii. T. |
| | 20 | 26 | iii. *e*. |
| | 23 | 52 | iii. E. |
| 3 | 0 | 41 | iii. *o*. |
| | 4 | 21 | iii. O. |
| | 4 | 25 | i. *t*. |
| | 6 | 45 | i. T. |
| 4 | 0 | 32 | i. *e*. |
| | 3 | 54 | i. O. |
| | 5 | 36 | ii. *e*. |
| | 10 | 39 | ii. O. |
| | 22 | 52 | i. *t*. |
| 5 | 1 | 12 | i. T. |
| | 19 | 1 | i. *e*. |
| | 22 | 21 | i. O. |
| 6 | 1 | 59 | ii. *t*. |
| | 4 | 54 | ii. T. |
| | 14 | 35 | iii. *t*. |
| | 17 | 19 | i. *t*. |
| | 18 | 15 | iii. T. |
| | 19 | 39 | i. T. |
| 7 | 13 | 29 | i. *e*. |
| | 16 | 48 | i. O. |
| | 18 | 54 | ii. *e*. |
| | 23 | 50 | ii. O. |
| 8 | 11 | 46 | i. *t*. |
| | 14 | 6 | i. T. |

*Dec.* (con.).

| d | h | m | |
|---|---|---|---|
| 9 | 7 | 57 | i. *e*. |
| | 11 | 15 | i. O. |
| | 15 | 9 | ii. *t*. |
| | 18 | 4 | ii. T. |
| 10 | 0 | 24 | iii. *e*. |
| | 1 | 13 | iv. *t*. |
| | 3 | 50 | iii. E. |
| | 4 | 15 | iii. *o*. |
| | 5 | 55 | iv. T. |
| | 6 | 13 | i. *t*. |
| | 7 | 55 | iii. O. |
| | 8 | 33 | i. T. |
| 11 | 2 | 26 | i. *e*. |
| | 5 | 41 | i. O. |
| | 8 | 12 | ii. *e*. |
| | 13 | 2 | ii. O. |
| 12 | 0 | 39 | i. *t*. |
| | 3 | 0 | i. T. |
| | 20 | 54 | i. *e*. |
| 13 | 0 | 8 | i. O. |
| | 4 | 19 | ii. *t*. |
| | 7 | 14 | ii. T. |
| | 18 | 7 | iii. *t*. |
| | 19 | 6 | i. *t*. |
| | 21 | 26 | i. T. |
| | 21 | 47 | iii. T. |
| 14 | 15 | 22 | i. *e*. |
| | 18 | 35 | i. O. |
| | 21 | 30 | ii. *e*. |
| 15 | 2 | 13 | ii. O. |
| | 13 | 33 | i. *t*. |
| | 15 | 53 | i. T. |
| 16 | 9 | 51 | i. *e*. |
| | 13 | 1 | i. O. |
| | 17 | 28 | ii. *t*. |
| | 20 | 24 | ii. T. |
| 17 | 4 | 22 | iii. *e*. |
| | 7 | 59 | i. *t*. |
| | 10 | 20 | i. T. |
| | 11 | 24 | iii. O. |
| 18 | 1 | 42 | iv. *e*. |
| | 4 | 19 | i. *e*. |
| | 6 | 3 | iv. E. |
| | 7 | 28 | i. O. |
| | 9 | 33 | iv. *o*. |
| | 10 | 47 | ii. *e*. |
| | 14 | 16 | iv. O. |
| | 15 | 23 | ii. O. |
| 19 | 2 | 26 | i. *t*. |
| | 4 | 47 | i. T. |
| | 22 | 47 | i. *e*. |

*Dec.* (con.)

| d | h | m | |
|---|---|---|---|
| 20 | 1 | 54 | i. |
| | 6 | 37 | ii. |
| | 9 | 33 | ii. |
| | 20 | 52 | i. |
| | 21 | 35 | iii. |
| | 23 | 13 | i. |
| 21 | 1 | 15 | iii. |
| | 17 | 16 | i. |
| | 20 | 20 | i. |
| 22 | 0 | 6 | ii. |
| | 4 | 32 | ii. |
| | 15 | 19 | i. |
| | 17 | 39 | i. |
| 23 | 11 | 44 | i. |
| | 14 | 47 | i. |
| | 19 | 46 | ii. |
| | 22 | 41 | ii. |
| 24 | 8 | 20 | iii. |
| | 9 | 45 | i. |
| | 12 | 5 | i. |
| | 14 | 49 | iii. |
| 25 | 6 | 13 | i. |
| | 9 | 13 | i. |
| | 13 | 23 | ii. |
| | 17 | 42 | ii. |
| 26 | 4 | 11 | i. |
| | 6 | 32 | i. |
| | 16 | 19 | iv. |
| | 21 | 2 | iv. |
| 27 | 0 | 41 | i. |
| | 3 | 39 | i. |
| | 8 | 54 | ii. |
| | 11 | 50 | ii. |
| | 22 | 38 | i. |
| 28 | 0 | 58 | i. |
| | 0 | 59 | iii |
| | 4 | 38 | iii |
| | 19 | 9 | i. |
| | 22 | 5 | i. |
| 29 | 2 | 41 | ii. |
| | 6 | 50 | ii. |
| | 17 | 4 | i. |
| | 19 | 24 | i. |
| 30 | 13 | 38 | i. |
| | 16 | 31 | i. |
| | 22 | 2 | ii. |
| 31 | 0 | 57 | ii. |
| | 11 | 30 | i. |
| | 12 | 18 | iii |
| | 13 | 50 | i. |
| | 18 | 11 | iii |

The satellites of Jupiter will be invisible from June 12 until August 8, Jupiter being too near to the

Satellite I. *reappears* at eclipse on the *f* side from January to June. It *disappears* on the *p* side
August to December.

Satellite II. *reappears* at eclipse on the *f* side from January to June. It *disappears* on the *p* side
August to December.

Satellite III. *disappears* and *reappears* at eclipse on the *f* side from January to May. In Ju
*reappears* on the *f* side. In August it *disappears* on the *p* side. In September, October, and Nove
*it disappears and reappears* on the *p* side. In December it *disappears* on the *p* side.

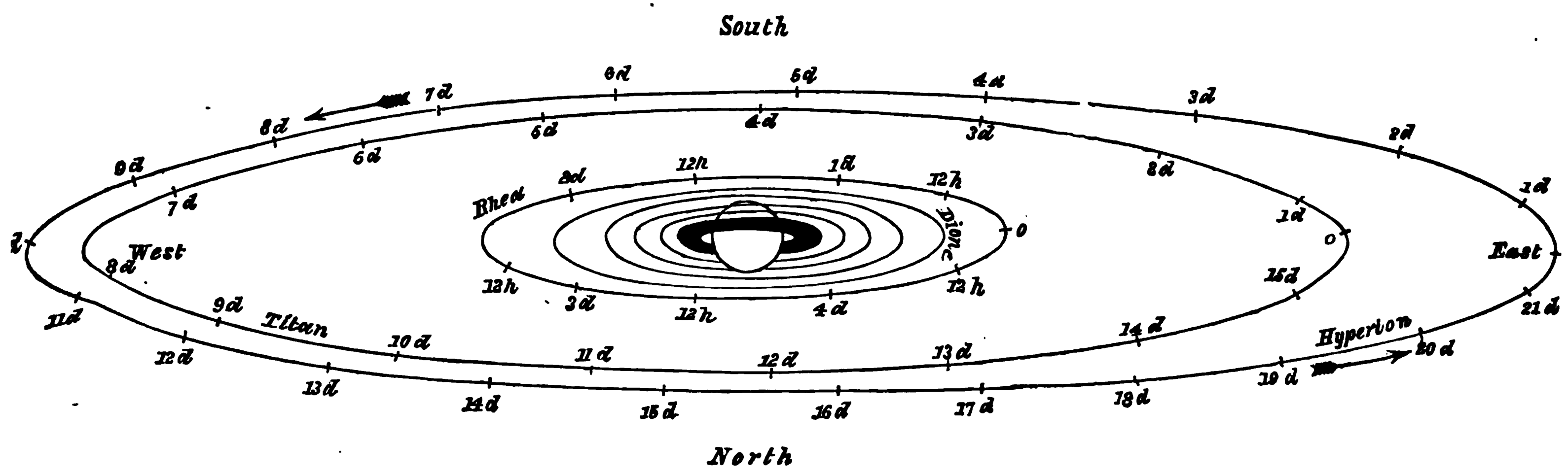
*Satellite IV. both disappears* and *reappears* on the *f* side from January to June. On the *p* side
*August to December.*

## EPHEMERIS OF JUPITER'S VTH SATELLITE.

| Noon. | P+90°. | *a*. | *b*. | *l*—L. | Time of greatest Elong<sup>n</sup> W. |
|---|---|---|---|---|---|
| | ° | ″ | ″ | ° | h m |
| Jan. 2 …… | 90.80 | 59.83 | +2.27 | 179.09 | 14 58 |
| 4 …… | 90.68 | 59.72 | 2.27 | 184.58 | 14 47 |
| 6 …… | 90.57 | 59.59 | 2.26 | 190.06 | 14 37 |
| 8 …… | 90.45 | 59.44 | 2.25 | 195.53 | 14 26 |
| 10 …… | 90.34 | 59.28 | 2.24 | 200.99 | 14 15 |
| 12 …… | 90.23 | 59.10 | 2.24 | 206.43 | 14 4 |
| 14 …… | 90.12 | 58.90 | 2.26 | 211.86 | 13 53 |
| 16 …… | 90.02 | 58.09 | 2.22 | 217.28 | 13 42 |
| 18 …… | 89.92 | 58.47 | 2.21 | 222.69 | 13 32 |
| 20 …… | 89.83 | 58.24 | 2.19 | 228.08 | 13 21 |
| 22 …… | 89.75 | 57.99 | 2.18 | 233.46 | 13 10 |
| 24 …… | 89.66 | 57.73 | 2.17 | 238.82 | 12 59 |
| 26 …… | 89.59 | 57.47 | 2.16 | 244.17 | 12 49 |
| 28 …… | 89.51 | 57.19 | 2.14 | 249.50 | 12 38 |
| 30 …… | 89.45 | 56.90 | 2.13 | 254.81 | 12 28 |
| Feb. 1 …… | 89.39 | 56.60 | 2.11 | 260.11 | 12 17 |
| 3 …… | 89.33 | 56.30 | 2.10 | 265.40 | 12 7 |
| 5 …… | 89.28 | 55.99 | 2.08 | 270.67 | 11 56 |
| 7 …… | 89.24 | 55.67 | 2.07 | 275.92 | 11 46 |
| 9 …… | 89.20 | 55.35 | 2.05 | 281.15 | 11 35 |
| 11 …… | 89.17 | 55.03 | 2.04 | 286.37 | 11 25 |
| 13 …… | 89.15 | 54.70 | 2.02 | 291.57 | 11 14 |
| 15 …… | 89.13 | 54.37 | 2.00 | 296.76 | 11 4 |
| 17 …… | 89.12 | 54.03 | 1.99 | 301.93 | 10 54 |
| 19 …… | 89.12 | 53.70 | 1.97 | 307.09 | 10 44 |
| 21 …… | 89.12 | 53.36 | 1.95 | 312.23 | 10 34 |
| 23 …… | 89.12 | 53.02 | 1.94 | 317.36 | 10 23 |
| 25 …… | 89.14 | 52.68 | 1.92 | 322.47 | 10 13 |
| 27 …… | 89.16 | 52.34 | 1.90 | 327.56 | 10 3 |
| Mar. 1 …… | 89.18 | 52.00 | 1.89 | 332.64 | 9 53 |
| 3 …… | 89.21 | 51.67 | 1.87 | 337.71 | 9 43 |
| 5 …… | 89.25 | 51.33 | 1.85 | 342.76 | 9 32 |
| 7 …… | 89.30 | 51.00 | 1.83 | 347.80 | 9 22 |
| 9 …… | 89.35 | 50.67 | 1.82 | 352.83 | 9 12 |
| 11 …… | 89.40 | 50.34 | 1.80 | 357.85 | 9 2 |
| 13 …… | 89.46 | 50.02 | 1.78 | 2.85 | 8 52 |
| 15 …… | 89.53 | 49.70 | 1.77 | 7.84 | 8 43 |
| 17 …… | 89.60 | 49.38 | 1.75 | 12.82 | 8 33 |
| 19 …… | 89.68 | 49.07 | 1.73 | 17.78 | 8 23 |
| 21 …… | 89.76 | 48.76 | 1.72 | 22.74 | 8 13 |
| 23 …… | 89.85 | 48.45 | 1.70 | 27.68 | 8 3 |
| 25 …… | 89.94 | 48.15 | 1.68 | 32.62 | 7 53 |
| 27 …… | 90.04 | 47.86 | 1.67 | 37.54 | 7 43 |
| 29 …… | 90.14 | 47.56 | 1.65 | 42.45 | 7 34 |
| 31 …… | 90.25 | 47.28 | +1.64 | 47.36 | 7 24 |

Rectangular coordinates are given by the formulæ $x=a \sin(l-L)$ in pos. P+90°, $y=b \cos(l-L)$ in pos. P.

## APPARENT ORBITS OF THE SEVEN INNER SATELLITES OF SATURN, as seen in an Inverting Telescope.



The arrows in the diagram show the direction of the motion of the Satellites. The figures indicate the interval from the time of last East Elongation.

# SATELLITES OF SATURN.

## East Elongations.

### MIMAS.

| January. | | February. | | March. | | April. | | May. | | June. | | July. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | h | d | h | d | h | d | h | d | h | d | h | d | h |
| 1 | 6·6 | 1 | 8·9 | 1 | 15·5 | 1 | 17·7 | 1 | 21·3 | 1 | 1·0 | 1 | 4·8 |
| 2 | 5·2 | 2 | 7·5 | 2 | 14·1 | 2 | 16·3 | 2 | 19·9 | 1 | 23·6 | 2 | 3·4 |
| 3 | 3·8 | 3 | 6·1 | 3 | 12·8 | 3 | 14·9 | 3 | 18·5 | 2 | 22·2 | 3 | 2·0 |
| 4 | 2·4 | 4 | 4·7 | 4 | 11·4 | 4 | 13·5 | 4 | 17·1 | 3 | 20·8 | 4 | 0·7 |
| 5 | 1·0 | 5 | 3·4 | 5 | 10·0 | 5 | 12·1 | 5 | 15·8 | 4 | 19·4 | 4 | 23·3 |
| 5 | 23·6 | 6 | 2·0 | 6 | 8·6 | 6 | 10·7 | 6 | 14·3 | 5 | 18·0 | 5 | 21·9 |
| 6 | 22·2 | 7 | 0·6 | 7 | 7·2 | 7 | 9·3 | 7 | 12·9 | 6 | 16·6 | 6 | 20·5 |
| 7 | 20·8 | 7 | 23·2 | 8 | 5·9 | 8 | 7·9 | 8 | 11·5 | 7 | 15·2 | 7 | 19·1 |
| 8 | 19·4 | 8 | 21·8 | 9 | 4·5 | 9 | 6·6 | 9 | 10·2 | 8 | 13·9 | 8 | 17·7 |
| 9 | 18·0 | 9 | 20·5 | 10 | 3·1 | 10 | 5·2 | 10 | 8·8 | 9 | 12·5 | 9 | 16·4 |
| 10 | 16·6 | 10 | 19·1 | 11 | 1·7 | 11 | 3·8 | 11 | 7·4 | 10 | 11·1 | 10 | 15·0 |
| 11 | 15·3 | 11 | 17·7 | 12 | 0·3 | 12 | 2·4 | 12 | 6·1 | 11 | 9·7 | 11 | 13·6 |
| 12 | 13·9 | 12 | 16·4 | 12 | 22·9 | 13 | 1·1 | 13 | 4·7 | 12 | 8·3 | 12 | 12·2 |
| 13 | 12·5 | 13 | 15·0 | 13 | 21·5 | 13 | 23·7 | 14 | 3·3 | 13 | 6·9 | 13 | 10·8 |
| 14 | 11·1 | 14 | 13·6 | 14 | 20·2 | 14 | 22·3 | 15 | 1·9 | 14 | 5·6 | 14 | 9·5 |
| 15 | 9·8 | 15 | 12·3 | 15 | 18·8 | 15 | 20·9 | 16 | 0·6 | 15 | 4·2 | 15 | 8·1 |
| 16 | 8·4 | 16 | 10·9 | 16 | 17·4 | 16 | 19·5 | 16 | 23·2 | 16 | 2·8 | 16 | 6·7 |
| 17 | 7·0 | 17 | 9·5 | 17 | 16·0 | 17 | 18·1 | 17 | 21·8 | 17 | 1·5 | 17 | 5·3 |
| 18 | 5·6 | 18 | 8·1 | 18 | 14·6 | 18 | 16·7 | 18 | 20·4 | 18 | 0·1 | 18 | 4·0 |
| 19 | 4·2 | 19 | 6·8 | 19 | 13·2 | 19 | 15·3 | 19 | 19·0 | 18 | 22·7 | 19 | 2·6 |
| 20 | 2·8 | 20 | 5·4 | 20 | 11·8 | 20 | 14·0 | 20 | 17·6 | 19 | 21·4 | 20 | 1·2 |
| 21 | 1·4 | 21 | 4·0 | 21 | 10·4 | 21 | 12·6 | 21 | 16·2 | 20 | 20·0 | 20 | 23·8 |
| 22 | 0·1 | 22 | 2·6 | 22 | 9·0 | 22 | 11·2 | 22 | 14·8 | 21 | 18·6 | 21 | 22·4 |
| 22 | 22·7 | 23 | 1·3 | 23 | 7·6 | 23 | 9·8 | 23 | 13·4 | 22 | 17·2 | 22 | 21·1 |
| 23 | 21·4 | 23 | 23·9 | 24 | 6·2 | 24 | 8·4 | 24 | 12·0 | 23 | 15·8 | 23 | 19·7 |
| 24 | 20·0 | 24 | 22·5 | 25 | 4·8 | 25 | 7·0 | 25 | 10·6 | 24 | 14·4 | 24 | 18·3 |
| 25 | 18·6 | 25 | 21·1 | 26 | 3·4 | 26 | 5·6 | 26 | 9·2 | 25 | 13·0 | 25 | 16·9 |
| 26 | 17·2 | 26 | 19·7 | 27 | 2·0 | 27 | 4·2 | 27 | 7·8 | 26 | 11·7 | 26 | 15·5 |
| 27 | 15·8 | 27 | 18·3 | 28 | 0·6 | 28 | 2·8 | 28 | 6·4 | 27 | 10·3 | 27 | 14·1 |
| 28 | 14·4 | 28 | 16·9 | 28 | 23·2 | 29 | 1·4 | 29 | 5·1 | 28 | 8·9 | 28 | 12·7 |
| 29 | 13·0 | | | 29 | 21·8 | 30 | 0·0 | 30 | 3·7 | 29 | 7·5 | 29 | 11·3 |
| 30 | 11·6 | | | 30 | 20·5 | 30 | 22·6 | 31 | 2·3 | 30 | 6·2 | 30 | 9·9 |
| 31 | 10·3 | | | 31 | 19·1 | | | | | | | 31 | 8·5 |

### ENCELADUS.

| January. | | February. | | March. | | April. | | May. | | June. | | July. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | h | d | h | d | h | d | h | d | h | d | h | d | h |
| 1 | 8·7 | 1 | 21·1 | 1 | 6·8 | 1 | 19·0 | 1 | 22·2 | 1 | 1·5 | 1 | 5·0 |
| 2 | 17·6 | 3 | 6·0 | 2 | 15·6 | 3 | 3·8 | 3 | 7·1 | 2 | 10·4 | 2 | 13·9 |
| 4 | 2·5 | 4 | 14·9 | 4 | 0·5 | 4 | 12·7 | 4 | 15·9 | 3 | 19·3 | 3 | 22·8 |
| 5 | 11·3 | 5 | 23·8 | 5 | 9·4 | 5 | 21·6 | 6 | 0·8 | 5 | 4·2 | 5 | 7·7 |
| 6 | 20·2 | 7 | 8·7 | 6 | 18·3 | 7 | 6·4 | 7 | 9·7 | 6 | 13·1 | 6 | 16·6 |
| 8 | 5·1 | 8 | 17·6 | 8 | 3·2 | 8 | 15·3 | 8 | 18·6 | 7 | 22·0 | 8 | 1·5 |
| 9 | 14·0 | 10 | 2·4 | 9 | 12·0 | 10 | 0·2 | 10 | 3·5 | 9 | 6·8 | 9 | 10·4 |
| 10 | 22·9 | 11 | 11·3 | 10 | 20·9 | 11 | 9·1 | 11 | 12·3 | 10 | 15·7 | 10 | 19·3 |
| 12 | 7·8 | 12 | 20·2 | 12 | 5·8 | 12 | 17·9 | 12 | 21·2 | 12 | 0·6 | 12 | 4·1 |
| 13 | 16·7 | 14 | 5·0 | 13 | 14·7 | 14 | 2·8 | 14 | 6·1 | 13 | 9·5 | 13 | 13·0 |
| 15 | 1·5 | 15 | 13·9 | 14 | 23·6 | 15 | 11·7 | 15 | 14·9 | 14 | 18·4 | 14 | 21·9 |
| 16 | 10·4 | 16 | 22·8 | 16 | 8·4 | 16 | 20·5 | 16 | 23·8 | 16 | 3·2 | 16 | 6·8 |
| 17 | 19·3 | 18 | 7·7 | 17 | 17·3 | 18 | 5·4 | 18 | 8·7 | 17 | 12·1 | 17 | 15·6 |
| 19 | 4·2 | 19 | 16·6 | 19 | 2·2 | 19 | 14·3 | 19 | 17·6 | 18 | 21·0 | 19 | 0·5 |
| 20 | 13·1 | 21 | 1·4 | 20 | 11·0 | 20 | 23·2 | 21 | 2·5 | 20 | 5·9 | 20 | 9·4 |
| 21 | 22·0 | 22 | 10·3 | 21 | 19·9 | 22 | 8·0 | 22 | 11·4 | 21 | 14·8 | 21 | 18·3 |
| 23 | 6·9 | 23 | 19·2 | 23 | 4·8 | 23 | 16·9 | 23 | 20·2 | 22 | 23·7 | 23 | 3·2 |
| 24 | 15·8 | 25 | 4·1 | 24 | 13·7 | 25 | 1·8 | 25 | 5·1 | 24 | 8·6 | 24 | 12·1 |
| 26 | 0·7 | 26 | 13·0 | 25 | 22·6 | 26 | 10·7 | 26 | 14·0 | 25 | 17·5 | 25 | 21·0 |
| 27 | 9·6 | 27 | 21·9 | 27 | 7·4 | 27 | 19·6 | 27 | 22·9 | 27 | 2·3 | 27 | 5·9 |
| 28 | 18·5 | | | 28 | 16·3 | 29 | 4·4 | 29 | 7·8 | 28 | 11·2 | 28 | 14·8 |
| 30 | 3·4 | | | 30 | 1·2 | 30 | 13·3 | 30 | 16·7 | 29 | 20·1 | 29 | 23·7 |
| 31 | 12·2 | | | 31 | 10·1 | | | | | | | 31 | 8·6 |

## East Elongations.

### TETHYS.

| January. | | February. | | March. | | April. | | May. | | June. | | July. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | h | d | h | d | h | d | h | d | h | d | h | d | h |
| 2 | 3·3 | 1 | 8·4 | 1 | 15·9 | 2 | 17·9 | 1 | 1·2 | 2 | 3·2 | 2 | 8·0 |
| 4 | 0·6 | 3 | 6·1 | 3 | 13·2 | 4 | 15·2 | 2 | 22·5 | 4 | 0·5 | 4 | 5·3 |
| 5 | 22·0 | 5 | 3·0 | 5 | 10·5 | 6 | 12·5 | 4 | 19·8 | 5 | 21·8 | 6 | 2·7 |
| 7 | 19·3 | 7 | 0·3 | 7 | 7·7 | 8 | 9·7 | 6 | 17·1 | 7 | 19·1 | 8 | 0·0 |
| 9 | 16·6 | 8 | 21·6 | 9 | 5·0 | 10 | 7·0 | 8 | 14·4 | 9 | 16·4 | 9 | 21·3 |
| 11 | 13·9 | 10 | 18·9 | 11 | 2·3 | 12 | 4·3 | 10 | 11·7 | 11 | 13·7 | 11 | 18·6 |
| 13 | 11·2 | 12 | 16·2 | 12 | 23·6 | 14 | 1·6 | 12 | 8·9 | 13 | 11·0 | 13 | 15·9 |
| 15 | 8·6 | 14 | 13·5 | 14 | 20·9 | 15 | 22·9 | 14 | 6·2 | 15 | 8·3 | 15 | 13·2 |
| 17 | 5·9 | 16 | 10·8 | 16 | 18·2 | 17 | 20·2 | 16 | 3·5 | 17 | 5·6 | 17 | 10·5 |
| 19 | 3·1 | 18 | 8·1 | 18 | 15·5 | 19 | 17·5 | 18 | 0·8 | 19 | 2·9 | 19 | 7·8 |
| 21 | 0·5 | 20 | 5·4 | 20 | 12·8 | 21 | 14·8 | 19 | 22·1 | 21 | 0·2 | 21 | 5·1 |
| 22 | 21·8 | 22 | 2·7 | 22 | 10·1 | 23 | 12·1 | 21 | 19·4 | 22 | 21·5 | 23 | 2·4 |
| 24 | 19·1 | 24 | 0·0 | 24 | 7·4 | 25 | 9·3 | 23 | 16·7 | 24 | 18·8 | 24 | 23·7 |
| 26 | 16·4 | 25 | 21·3 | 26 | 4·7 | 27 | 6·6 | 25 | 14·0 | 26 | 16·1 | 26 | 21·0 |
| 28 | 13·7 | 27 | 18·6 | 28 | 2·0 | 29 | 3·9 | 27 | 11·3 | 28 | 13·4 | 28 | 18·3 |
| 30 | 11·1 | | | 29 | 23·3 | | | 29 | 8·6 | 30 | 10·7 | 30 | 15·6 |
| | | | | 31 | 20·6 | | | 31 | 5·9 | | | | |

### DIONE.

| January. | | February. | | March. | | April. | | May. | | June. | | July. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | h | d | h | d | h | d | h | d | h | d | h | d | h |
| 1 | 9·0 | 3 | 5·5 | 2 | 14·3 | 1 | 16·5 | 1 | 18·6 | 3 | 14·5 | 3 | 17·0 |
| 4 | 2·7 | 5 | 23·2 | 5 | 7·9 | 4 | 10·1 | 4 | 12·3 | 6 | 8·2 | 6 | 10·7 |
| 6 | 20·4 | 8 | 16·8 | 8 | 1·6 | 7 | 3·8 | 7 | 5·9 | 9 | 1·9 | 9 | 4·4 |
| 9 | 14·1 | 11 | 10·5 | 10 | 19·2 | 9 | 21·5 | 9 | 23·6 | 11 | 19·5 | 11 | 22·1 |
| 12 | 7·8 | 14 | 4·2 | 13 | 12·9 | 12 | 15·1 | 12 | 17·2 | 14 | 13·2 | 14 | 15·8 |
| 15 | 1·6 | 16 | 21·9 | 16 | 6·6 | 15 | 8·7 | 15 | 10·9 | 17 | 6·9 | 17 | 9·5 |
| 17 | 19·3 | 19 | 15·6 | 19 | 0·2 | 18 | 2·4 | 18 | 4·6 | 20 | 0·6 | 20 | 3·2 |
| 20 | 13·0 | 22 | 9·3 | 21 | 17·9 | 20 | 20·0 | 20 | 22·2 | 22 | 18·3 | 22 | 20·9 |
| 23 | 6·7 | 25 | 3·0 | 24 | 11·6 | 23 | 13·7 | 23 | 15·9 | 25 | 11·9 | 25 | 14·6 |
| 26 | 0·4 | 27 | 20·6 | 27 | 5·2 | 26 | 7·3 | 26 | 9·5 | 28 | 5·6 | 28 | 8·3 |
| 28 | 18·1 | | | 29 | 22·9 | 29 | 1·0 | 29 | 3·2 | 30 | 23·3 | 31 | 2·0 |
| 31 | 11·8 | | | | | | | 31 | 20·9 | | | | |

### RHEA.

| January. | | February. | | March. | | April. | | May. | | June. | | July. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | h | d | h | d | h | d | h | d | h | d | h | d | h |
| 3 | 12·3 | 4 | 3·6 | 3 | 6·1 | 3 | 20·4 | 5 | 10·7 | 1 | 12·7 | 3 | 3·5 |
| 8 | 0·8 | 8 | 16·0 | 7 | 18·4 | 8 | 8·8 | 9 | 23·1 | 6 | 1·1 | 7 | 15·9 |
| 12 | 13·3 | 13 | 4·4 | 12 | 6·8 | 12 | 21·1 | 14 | 11·4 | 10 | 13·5 | 12 | 4·4 |
| 17 | 1·8 | 17 | 16·8 | 16 | 19·1 | 17 | 9·4 | 18 | 23·7 | 15 | 1·9 | 16 | 16·8 |
| 21 | 14·3 | 22 | 5·2 | 21 | 7·5 | 21 | 21·7 | 23 | 12·0 | 19 | 14·3 | 21 | 5·2 |
| 26 | 2·7 | 26 | 17·7 | 25 | 19·8 | 26 | 10·1 | 28 | 0·4 | 24 | 2·7 | 25 | 17·6 |
| 30 | 15·2 | | | 30 | 8·1 | 30 | 22·4 | | | 28 | 15·1 | 30 | 6·0 |

### TITAN.

| January. | | February. | | March. | | April. | | May. | | June. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | h | d | h | d | h | d | h | d | h | d | h | |
| 9 | 14·8 | 10 | 13·4 | 14 | 10·1 | 15 | 6·1 | 1 | 3·9 | 1 | 23·0 | ...... |
| 25 | 13·8 | 26 | 12·5 | 30 | 8·5 | | | 17 | 1·6 | 17 | 20·5 | ...... |

## East Elongations.

### HYPERION.

| January. | February. | March. | April. | May. | June. | July. | August. |
|---|---|---|---|---|---|---|---|
| d h | d h | d h | d h | d h | d h | d h | d h |
| 3 13·4 | 15 4·5 | 8 10·8 | 19 21·6 | 11 2·5 | 1 7·8 | 13 20·8 | 4 4·4 |
| 24 21·8 | | 29 16·5 | | | 22 13·5 | | |

### IAPETUS.

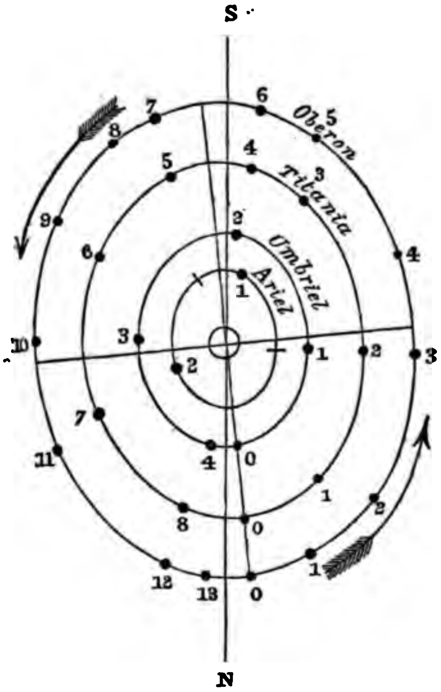
d h d h d h d h
Inf. Conjunction ... Mar. 13 17·1, May 30 22·7.
W. Elongation ...... Jan. 13 20·5, Apr. 2 23·3, June 20 4·6.
Sup. Conjunction ... Feb. 3 0·0, Apr. 23 2·9, July 10 4·5, Dec. 19 4·7.
E. Elongation ...... Feb. 23 17·7, May 13 1·3, July 31 1·9.

## Apparent Elements of Saturn's Rings.

| Greenwich Mean Noon. | Position-angle of Minor Axis. | Outer Ring. Maj. Axis. | Outer Ring. Min. Axis. | Latitude above Plane of Ring. Earth. | Latitude above Plane of Ring. Sun. |
|---|---|---|---|---|---|
| | ° ′ | ″ | ″ | ° ′ | ° ′ |
| Jan. 0 ......... | 359 38·0 | 36·93 | 11·47 | 18 6·1 N. | 16 11·5 N. |
| 20 ......... | 359 47·0 | 38·12 | 12·04 | 18 25·3 N. | 16 25·7 N. |
| Feb. 9 ......... | 359 51·1 | 39·45 | 12·53 | 18 31·1 N. | 16 39·8 N. |
| Mar. 1 ......... | 359 50·1 | 40·75 | 12·85 | 18 23·4 N. | 16 53·6 N. |
| 21 ......... | 359 44·4 | 41·83 | 12·97 | 18 3·8 N. | 17 7·3 N. |
| April 10 ......... | 359 35·1 | 42·49 | 12·85 | 17 35·8 N. | 17 20·8 N. |
| 30 ......... | 359 24·2 | 42·61 | 12·52 | 17 4·9 N. | 17 34·3 N. |
| May 20 ......... | 359 14·0 | 42·15 | 12·06 | 16 37·1 N. | 17 47·6 N. |
| June 9 ......... | 359 6·4 | 41·23 | 11·57 | 16 18·4 N. | 18 0·8 N. |
| 29 ......... | 359 2·9 | 40·00 | 11·17 | 16 12·8 N. | 18 13·9 N. |
| July 19 ......... | 359 3·8 | 38·68 | 10·90 | 16 21·6 N. | 18 26·7 N. |
| Aug. 8 ......... | 359 9·3 | 37·41 | 10·76 | 16 43·9 N. | 18 39·5 N. |
| 28 ......... | 359 18·9 | 36·30 | 10·79 | 17 17·3 N. | 18 52·1 N. |
| Sept. 17 ......... | 359 31·9 | 35·44 | 10·93 | 17 58·6 N. | 19 4·6 N. |
| Oct. 7 ......... | 359 47·7 | 34·87 | 11·20 | 18 44·3 N. | 19 17·0 N. |
| 27 ......... | 0 5·1 | 34·61 | 11·56 | 19 31·0 N. | 19 29·2 N. |
| Nov. 16 ......... | 0 23·3 | 34·67 | 12·00 | 20 15·1 N. | 19 41·3 N. |
| Dec. 6 ......... | 0 40·6 | 35·06 | 12·51 | 20 54·2 N. | 19 53·2 N. |
| 26 ......... | 0 56·7 | 35·76 | 13·07 | 21 25·8 N. | 20 5·0 N. |
| 31 ......... | 1 0·3 | 35·99 | 13·21 | 21 32·3 N. | 20 7·9 N. |

## TABLE OF BESSEL'S MEAN REFRACTIONS.

| Z. D. | Mean Refraction. | Z. D. | Mean Refraction. | Z. D. | Mean Refraction. | Z. D. | Mean Refraction. |
|---|---|---|---|---|---|---|---|
| ° | ′ ″ | ° | ′ ″ | ° | ′ ″ | ° | ′ ″ |
| 0 | 0·0 | 56 | 1 25·4 | 68 | 2 21·9 | 78 | 4 25·0 |
| 10 | 10·2 | 58 | 1 32·1 | 69 | 2 29·3 | 79 | 4 48·5 |
| 20 | 21·0 | 60 | 1 39·7 | 70 | 2 37·3 | 80 | 5 16·2 |
| 30 | 33·3 | 61 | 1 43·8 | 71 | 2 46·1 | 81 | 5 49·3 |
| 35 | 40·4 | 62 | 1 48·2 | 72 | 2 55·8 | 82 | 6 29·6 |
| 40 | 48·4 | 63 | 1 52·8 | 73 | 3 6·6 | 83 | 7 19·7 |
| 45 | 57·7 | 64 | 1 57·8 | 74 | 3 18·6 | 84 | 8 23·3 |
| 50 | 1 8·7 | 65 | 2 3·2 | 75 | 3 32·2 | 85 | 9 46·5 |
| 52 | 1 13·8 | 66 | 2 8·9 | 76 | 3 47·4 | | |
| 54 | 1 19·3 | 67 | 2 15·2 | 77 | 4 4·9 | | |



Apparent Orbits of the Satellites of Uranus, as seen in an inverting telescope.

The small circle in the above diagram represents the planet, the arrows show the direction of motion, and the figures indicate the interval from the time of the last North Elongation.

## North Elongations.

### Ariel.

| February. | | March. | | April. | | May. | | June. | | July. | | August. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | h | d | h | d | h | d | h | d | h | d | h | d | h |
| 1 | 22·4 | 1 | 15·8 | 3 | 10·2 | 1 | 3·6 | 2 | 22·0 | 3 | 4·0 | 2 | 9·9 |
| 4 | 10·9 | 4 | 4·3 | 5 | 22·7 | 3 | 16·1 | 5 | 10·5 | 5 | 16·5 | 4 | 22·4 |
| 6 | 23·4 | 6 | 16·8 | 8 | 11·2 | 6 | 4·6 | 7 | 23·0 | 8 | 5·0 | 7 | 10·9 |
| 9 | 11·9 | 9 | 5·3 | 10 | 23·6 | 8 | 17·1 | 10 | 11·5 | 10 | 17·5 | 9 | 23·4 |
| 12 | 0·4 | 11 | 17·7 | 13 | 12·1 | 11 | 5·5 | 13 | 0·0 | 13 | 6·0 | 12 | 11·9 |
| 14 | 12·9 | 14 | 6·2 | 16 | 0·6 | 13 | 18·0 | 15 | 12·5 | 15 | 18·5 | 15 | 0·4 |
| 17 | 1·3 | 16 | 18·7 | 18 | 13·1 | 16 | 6·5 | 18 | 1·0 | 18 | 7·0 | | |
| 19 | 13·8 | 19 | 7·2 | 21 | 1·6 | 18 | 19·0 | 20 | 13·5 | 20 | 19·5 | | |
| 22 | 2·3 | 21 | 19·7 | 23 | 14·1 | 21 | 7·5 | 23 | 2·0 | 23 | 8·0 | | |
| 24 | 14·8 | 24 | 8·2 | 26 | 2·6 | 23 | 20·0 | 25 | 14·5 | 25 | 20·4 | | |
| 27 | 3·3 | 26 | 20·7 | 28 | 15·1 | 26 | 8·5 | 28 | 3·0 | 28 | 8·9 | | |
| | | 29 | 9·2 | | | 28 | 21·0 | 30 | 15·5 | 30 | 21·4 | | |
| | | 31 | 21·7 | | | 31 | 9·5 | | | | | | |

**UMBRIEL.**

| January. | February. | March. | April. | May. | June. | July. | August. |
|---|---|---|---|---|---|---|---|
| d h | d h | d h | d h | d h | d h | d h | d h |
| 27 22·6 | 2 2·1 | 2 2·3 | 4 6·1 | 3 6·3 | 1 6·7 | 4 10·5 | 2 10·9 |
| | 5 5·5 | 6 5·8 | 8 9·6 | 7 9·8 | 5 10·2 | 8 14·0 | 6 14·3 |
| | 9 9·0 | 10 9·3 | 12 13·0 | 11 13·3 | 9 13·6 | 12 17·5 | 10 17·8 |
| | 13 12·4 | 14 12·8 | 16 16·5 | 15 16·8 | 13 17·1 | 16 21·0 | 14 21·3 |
| | 17 15·9 | 18 16·2 | 20 19·9 | 19 20·3 | 17 20·6 | 21 0·4 | |
| | 21 19·4 | 22 19·7 | 24 23·4 | 23 23·7 | 22 0·1 | 25 3·9 | |
| | 25 22·9 | 26 23·1 | 29 2·9 | 28 3·2 | 26 3·6 | 29 7·4 | |
| | | 31 2·6 | | | 30 7·1 | | |

**TITANIA.**

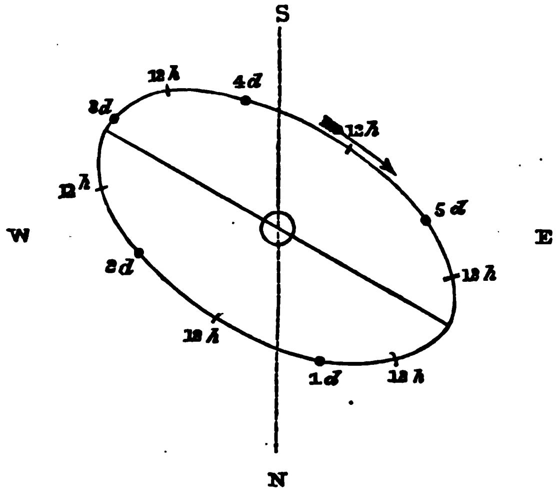
| January. | February. | March. | April. | May. | June. | July. | August. |
|---|---|---|---|---|---|---|---|
| 23 0·4 | 9 10·4 | 7 13·4 | 2 16·4 | 7 12·4 | 2 15·4 | 7 11·5 | 2 14·5 |
| 31 17·4 | 18 3·4 | 16 6·4 | 11 9·4 | 16 5·4 | 11 8·4 | 16 4·5 | 11 7·5 |
| | 26 20·4 | 24 23·4 | 20 2·4 | 24 22·4 | 20 1·4 | 24 21·5 | 20 0·5 |
| | | | 28 19·4 | | 28 18·4 | | |

**OBERON.**

| January. | February. | March. | April. | May. | June. | July. | August. |
|---|---|---|---|---|---|---|---|
| ...... | 7 0·4 | 5 22·9 | 1 21·4 | 12 7·2 | 8 5·8 | 5 4·3 | ...... |
| ...... | 20 11·7 | 19 10·2 | 15 8·7 | 25 18·5 | 21 17·0 | 18 15·5 | ...... |
| | | | 28 19·9 | | | | |

Position-angle and distance of the apse of Oberon:—February 9, 358°·7, 43″·4; May 8, +0°·3, 45″·7; August 8, +1°·7, 43″·3.

## SATELLITE OF NEPTUNE.



Apparent Orbit of the Satellite of Neptune, as seen in an inverting telescope.

The small circle in the above diagram represents the planet, the arrows show the direction of motion, and the figures indicate the interval from the time of last North-east Elongation.

**North-east Elongations.**

| January. | February. | [illegible] | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|
| d h | d h | d h | d h | d h | d h | d h | d h |
| 4 9·0 | 2 18·5 | 4 4·0 | 21 11·8 | 2 5·9 | 1 15·4 | 5 21·8 | 5 7·3 |
| 10 6·2 | 8 15·6 | 10 1·1 | 27 8·9 | 8 3·0 | 7 12·4 | 11 18·9 | 11 4·3 |
| 16 3·2 | 14 12·7 | | | 14 0·1 | 13 9·5 | 17 16·0 | 17 1·4 |
| 22 0·3 | 20 9·8 | | | 19 21·2 | 19 6·6 | 23 13·1 | 22 22·5 |
| 27 21·4 | 26 6·9 | | | 25 18·3 | 25 3·7 | 29 10·2 | 20 19·6 |
| | | | | | 31 0·8 | | |

*Position-angle and distance of the apse:*—March 1, 248°·1, 16″·4; *September 16, 253°·4, 16″·5; December 8, 251°·9, 17″·6.*

## EPHEMERIS FOR PHYSICAL OBSERVATIONS OF THE SUN.

| Greenwich Mean Noon. | | | | Greenwich Mean Noon. | | | |
|---|---|---|---|---|---|---|---|
| 1895. | P. | D. | L. | 1895. | P. | D. | L. |
| | ° ′ | ° ′ | ° ′ | | ° ′ | ° ′ | ° ′ |
| Jan. 1 | + 1 48 | −3 16 | 14 59 | July 5 | − 0 42 | +3 32 | 93 10 |
| 6 | − 0 38 | 3 50 | 309 9 | 10 | + 1 35 | 4 2 | 26 59 |
| 11 | 3 4 | 4 22 | 243 18 | 15 | 3 50 | 4 31 | 320 49 |
| 16 | 5 26 | 4 51 | 177 27 | 20 | 6 3 | 4 59 | 254 39 |
| 21 | 7 45 | 5 19 | 111 37 | 25 | 8 12 | 5 24 | 188 31 |
| 26 | 9 58 | 5 44 | 45 49 | 30 | 10 16 | 5 47 | 122 24 |
| 31 | 12 6 | 6 6 | 339 59 | Aug. 4 | 12 16 | 6 8 | 56 16 |
| Feb. 5 | 14 6 | 6 26 | 274 9 | 9 | 14 9 | 6 26 | 350 8 |
| 10 | 15 59 | 6 42 | 208 18 | 14 | 15 56 | 6 41 | 284 2 |
| 15 | 17 44 | 6 55 | 142 27 | 19 | 17 36 | 6 54 | 217 59 |
| 20 | 19 20 | 7 5 | 76 37 | 24 | 19 9 | 7 4 | 151 55 |
| 25 | 20 48 | 7 11 | 10 46 | 29 | 20 34 | 7 11 | 85 51 |
| Mar. 2 | 22 6 | 7 15 | 304 54 | Sept. 3 | 21 51 | 7 14 | 19 47 |
| 7 | 23 14 | 7 15 | 239 1 | 8 | 23 0 | 7 15 | 313 47 |
| 12 | 24 13 | 7 11 | 173 8 | 13 | 23 59 | 7 12 | 247 45 |
| 17 | 25 1 | 7 4 | 107 13 | 18 | 24 49 | 7 7 | 181 45 |
| 22 | 25 39 | 6 54 | 41 18 | 23 | 25 29 | 6 58 | 115 45 |
| 27 | 26 7 | 6 42 | 335 21 | 28 | 26 0 | 6 46 | 49 45 |
| Apr. 1 | 26 24 | 6 26 | 269 24 | Oct. 3 | 26 20 | 6 31 | 343 47 |
| 6 | 26 30 | 6 7 | 203 25 | 8 | 26 29 | 6 13 | 277 49 |
| 11 | 26 25 | 5 45 | 137 24 | 13 | 26 28 | 5 52 | 211 52 |
| 16 | 26 9 | 5 22 | 71 25 | 18 | 26 15 | 5 29 | 145 55 |
| 21 | 25 42 | 4 56 | 5 22 | 23 | 25 50 | 5 3 | 79 59 |
| 26 | 25 4 | 4 27 | 299 18 | 28 | 25 14 | 4 34 | 14 2 |
| May 1 | 24 15 | 3 57 | 233 14 | Nov. 2 | 24 26 | 4 4 | 308 7 |
| 6 | 23 15 | 3 26 | 167 8 | 7 | 23 26 | 3 31 | 242 12 |
| 11 | 22 5 | 2 53 | 101 1 | 12 | 22 15 | 2 57 | 176 16 |
| 16 | 20 44 | 2 19 | 34 53 | 17 | 20 52 | 2 22 | 110 22 |
| 21 | 19 14 | 1 44 | 328 44 | 22 | 19 17 | 1 45 | 44 26 |
| 26 | 17 34 | 1 8 | 262 34 | 27 | 17 33 | 1 8 | 338 33 |
| 31 | 15 46 | −0 32 | 196 25 | Dec. 2 | 15 38 | +0 30 | 272 40 |
| June 5 | 13 51 | +0 4 | 130 15 | 7 | 13 36 | −0 9 | 206 45 |
| 10 | 11 49 | 0 40 | 64 4 | 12 | 11 25 | 0 47 | 140 53 |
| 15 | 9 42 | 1 16 | 357 52 | 17 | 9 7 | 1 25 | 75 1 |
| 20 | 7 31 | 1 51 | 291 40 | 22 | 6 46 | 2 3 | 9 10 |
| 25 | 5 15 | 2 26 | 225 30 | 27 | 4 21 | 2 39 | 303 19 |
| 30 | − 2 59 | +2 59 | 159 21 | 32 | + 1 55 | −3 15 | 237 27 |

The position-angle of the Sun's axis, P, is the position-angle of the N. end of the axis from the N. point of the Sun, read in the direction N., E., S., W. In computing D (the heliographic latitude of the centre of the Sun's disk), the inclination of the Sun's axis to the ecliptic has been assumed to be 82° 45′, and the longitude of the ascending node to be 74° 20′. In computing L (the heliographic longitude of the centre of the disk), the Sun's period of rotation has been assumed to be 25·38 days, and the meridian which passed through the ascending node at the epoch 1854·0 has been taken as the zero meridian.

## MEAN PLACES OF VARIABLE STARS FOR 1895·0.

| No. | Star. | R.A. | Dec. | No. | Star. | R.A. | Dec. |
|---|---|---|---|---|---|---|---|
| | | h m s | ° ′ | | | h m s | ° ′ |
| 1. | S Sculptoris ... | 0 10 4 | −32 37·8 | 58. | R Cancri......... | 8 10 47 | +12 2·9 |
| 2. | T Andromedæ . | 0 16 54 | +26 24·8 | 59. | V Cancri......... | 8 15 44 | +17 37·1 |
| 3. | T Cassiopeiæ ... | 0 17 33 | +55 12·6 | 60. | V Carini ......... | 8 26 35 | −59 46·1 |
| 4. | R Andromedæ . | 0 18 29 | +37 59·8 | 61. | U Cancri......... | 8 29 46 | +19 15·5 |
| 5. | S Ceti ............ | 0 18 43 | − 9 54·6 | 62. | S Velorum ... .. | 8 34 16 | −46 59·6 |
| 6. | U Cassiopeiæ ... | 0 40 29 | +47 41·0 | 63. | S Cancri ......... | 8 37 56 | +19 24·7 |
| 7. | U Cephei ...... | 0 52 58 | +81 18·6 | 64. | S Hydræ ......... | 8 48 5 | + 3 27·9 |
| 8. | S Cassiopeiæ ... | 1 11 56 | +72 3·5 | 65. | T Hydræ......... | 8 50 33 | − 8 44·5 |
| 9. | S Piscium ...... | 1 12 5 | + 8 22·7 | 66. | T Cancri ......... | 8 50 41 | +20 15·1 |
| 10. | U Piscium ...... | 1 17 25 | +12 19·0 | 67. | W Carini......... | 9 19 6 | −55 30·7 |
| 11. | R Sculptoris ... | 1 22 8 | −33 5·2 | 68. | S Antliæ ......... | 9 27 43 | −28 9·9 |
| 12. | R Piscium ...... | 1 25 13 | + 2 20·4 | 69. | N Velorum ...... | 9 28 2 | −56 34·3 |
| 13. | S Arietis ......... | 1 59 0 | +12 1·4 | 70. | S Velorum ...... | 9 29 16 | −44 44·6 |
| 14. | R Arietis......... | 2 10 8 | +24 34·1 | 71. | R Carini ......... | 9 29 36 | −62 19·5 |
| 15. | o Ceti ............ | 2 14 2 | − 3 27·2 | 72. | R Leo. Min. ... | 9 39 17 | +34 59·7 |
| 16. | R Ceti............. | 2 20 40 | − 0 39·2 | 73. | R Leonis ...... | 9 41 55 | +11 55·0 |
| 17. | U Ceti............. | 2 28 41 | −13 36·6 | 74. | *l* Carini ......... | 9 42 22 | −62 1·4 |
| 18. | R Trianguli ... | 2 30 41 | +33 48·4 | 75. | V Leonis ...... | 9 54 14 | +21 45·8 |
| 19. | T Arietis......... | 2 42 28 | +17 4·3 | 76. | S Carini ......... | 10 6 1 | −61 2·2 |
| 20. | Algol ............ | 3 1 20 | +40 33·1 | 77. | R Ursæ Maj. ... | 10 37 13 | +69 19·6 |
| 21. | U Arietis ...... | 3 5 14 | +14 24·1 | 78. | V Hydræ ...... | 10 46 31 | −20 41·6 |
| 22. | R Persei ......... | 3 23 22 | +35 18·9 | 79. | W Leonis ...... | 10 48 5 | +14 16·5 |
| 23. | λ Tauri ......... | 3 54 52 | +12 11·7 | 80. | U Carini ......... | 10 53 31 | −59 10·2 |
| 24. | W Tauri......... | 4 22 2 | +15 52·1 | 81. | S Leonis ......... | 11 5 25 | + 6 1·8 |
| 25. | R Tauri ......... | 4 22 33 | + 9 55·7 | 82. | R Comæ ......... | 11 58 52 | +19 22·2 |
| 26. | S Tauri ......... | 4 23 27 | + 9 42·8 | 83. | S Muscæ ......... | 12 7 8 | −69 34·1 |
| 27. | T Camelopardi . | 4 29 57 | +65 58·2 | 84. | T Virginis ...... | 12 9 13 | − 5 27·1 |
| 28. | R Reticuli ...... | 4 32 27 | −63 14·8 | 85. | R Corvi ......... | 12 14 11 | −18 40·3 |
| 29. | V Tauri ......... | 4 45 57 | +17 21·7 | 86. | R Crucis ......... | 12 17 52 | −61 2·8 |
| 30. | R Orionis ...... | 4 53 19 | + 7 58·3 | 87. | Y Virginis ...... | 12 28 28 | − 3 50·6 |
| 31. | R Leporis ...... | 4 54 49 | −14 57·9 | 88. | T Ursæ Maj. ... | 12 31 37 | +60 3·9 |
| 32. | V Orionis ...... | 5 0 32 | + 3 57·5 | 89. | R Virginis ...... | 12 33 10 | + 7 34·0 |
| 33. | R Aurigæ ...... | 5 8 49 | +53 28·1 | 90. | R Muscæ......... | 12 35 40 | −68 49·9 |
| 34. | S Orionis......... | 5 23 49 | − 4 46·6 | 91. | S Ursæ Maj. ... | 12 39 21 | +61 40·1 |
| 35. | S Camelopardi . | 5 29 41 | +68 44·4 | 92. | U Virginis ...... | 12 45 46 | + 6 7·5 |
| 36. | U Aurigæ ...... | 5 35 13 | +31 58·5 | 93. | S Crucis ......... | 12 48 9 | −57 51·6 |
| 37. | U Orionis ...... | 5 49 35 | +20 9·3 | 94. | W Virginis...... | 13 20 37 | − 2 50·0 |
| 38. | η Geminorum... | 6 8 32 | +22 32·2 | 95. | V Virginis ...... | 13 22 23 | − 2 37·7 |
| 39. | V Aurigæ ...... | 6 15 56 | +47 42·8 | 96. | R Hydræ ...... | 13 23 59 | −22 44·3 |
| 40. | V Monocerotis.. | 6 17 26 | − 2 8·6 | 97. | S Virginis ...... | 13 27 31 | − 6 39·3 |
| 41. | T Monocerotis... | 6 19 33 | + 7 8·6 | 98. | W Hydræ ...... | 13 43 6 | −27 50·5 |
| 42. | S Monocerotis . | 6 35 12 | + 9 59·4 | 99. | R Canum Ven. . | 13 44 27 | +40 3·9 |
| 43. | R Lyncis......... | 6 52 38 | +55 28·7 | 100. | R² Virginis...... | 13 59 19 | − 8 41·7 |
| 44. | ζ Geminorum ... | 6 57 53 | +20 43·4 | 101. | Z Virginis ...... | 14 4 41 | −12 48·4 |
| 45. | R Geminorum . | 7 1 2 | +22 51·9 | 102. | R Centauri ...... | 14 9 0 | −59 25·4 |
| 46. | R Canis Min. ... | 7 2 56 | +10 11·3 | 103. | Y Boötis ......... | 14 17 8 | +20 17·2 |
| 47. | L² Puppis ...... | 7 10 20 | −44 28·3 | 104. | X Boötis ......... | 14 19 13 | +16 47·8 |
| 48. | R Canis Maj. ... | 7 14 43 | −16 11·9 | 105. | S Boötis ......... | 14 19 22 | +54 17·3 |
| 49. | V Geminorum... | 7 17 16 | +13 17·6 | 106. | S² Virginis ...... | 14 21 51 | + 5 3·4 |
| 50. | U Monocerotis.. | 7 25 47 | − 9 33·4 | 107. | R Camelopardi . | 14 25 31 | +84 18·5 |
| 51. | S Canis Min. ... | 7 27 1 | + 8 32·6 | 108. | V Boötis ......... | 14 25 31 | +39 19·8 |
| 52. | T Canis Min. ... | 7 28 10 | +11 58·1 | 109. | R Boötis ......... | 14 32 34 | +27 11·5 |
| 53. | U Canis Min. ... | 7 35 38 | + 8 37·5 | 110. | V Libræ ......... | 14 34 31 | −17 12·3 |
| 54. | S Geminorum .. | 7 36 45 | +23 41·8 | 111. | U Boötis ......... | 14 49 28 | +18 7·4 |
| 55. | T Geminorum .. | 7 43 0 | +23 59·7 | 112. | δ Libræ ......... | 14 55 22 | − 8 6·1 |
| 56. | U Geminorum . | 7 48 53 | +22 16·6 | 113. | T Triang. Austr. | 14 59 57 | −68 18·9 |
| 57. | U Puppis ...... | 7 55 13 | −48 57·6 | 114. | T Libræ ......... | 15 4 45 | −19 37·1 |

*Mean Places of Variable Stars for* 1895·0 (continued).

| No. | Star. | R.A. | | | Dec. | | No. | Star. | R.A. | | | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | h | m | s | ° | ′ | | | h | m | s | ° | |
| 115. | Y Libræ ......... | 15 | 6 | 8 | −5 | 36·8 | 170. | S Sagittarii...... | 19 | 13 | 17 | −19 | 12·9 |
| 116. | R Triang. Austr. | 15 | 10 | 23 | −66 | 6·6 | 171. | Z Sagittarii...... | 19 | 13 | 30 | −21 | 7·1 |
| 117. | U Coronæ ...... | 15 | 13 | 55 | +32 | 1·9 | 172. | T Sagittæ ...... | 19 | 17 | 1 | +17 | 27·3 |
| 118. | S Libræ ......... | 15 | 15 | 21 | −20 | 0·5 | 173. | U Aquilæ ...... | 19 | 23 | 42 | −7 | 15·6 |
| 119. | S Serpentis...... | 15 | 16 | 45 | +14 | 41·5 | 174. | R Cygni .. ...... | 19 | 34 | 0 | +49 | 57·9 |
| 120. | S Coronæ ...... | 15 | 17 | 7 | +31 | 44·7 | 175. | T² Cygni......... | 19 | 40 | 41 | +48 | 31·2 |
| 121. | S² Libræ......... | 15 | 18 | 13 | −22 | 32·9 | 176. | S Vulpeculæ ... | 19 | 44 | 5 | +27 | 1·5 |
| 122. | X Libræ ......... | 15 | 30 | 8 | −20 | 48·9 | 177. | X Aquilæ......... | 19 | 46 | 16 | +4 | 11·8 |
| 123. | W Libræ......... | 15 | 31 | 55 | −15 | 49·6 | 178. | χ Cygni ......... | 19 | 46 | 32 | +32 | 38·9 |
| 124. | U Libræ ......... | 15 | 35 | 56 | −20 | 50·5 | 179. | η Aquilæ......... | 19 | 47 | 8 | +0 | 44·2 |
| 125. | Z Libræ ......... | 15 | 40 | 24 | −20 | 47·8 | 180. | R² Sagittarii ... | 19 | 49 | 24 | −29 | 27·8 |
| 126. | V Coronæ ...... | 15 | 45 | 46 | +39 | 53·2 | 181. | S Sagittæ ...... | 19 | 51 | 14 | +16 | 21·2 |
| 127. | R Serpentis...... | 15 | 45 | 51 | +15 | 27·2 | 182. | Z Cygni ......... | 19 | 58 | 29 | +49 | 45·0 |
| 128. | R Libræ ......... | 15 | 47 | 39 | −15 | 55·4 | 183. | S Cygni ......... | 20 | 3 | 18 | +57 | 41·0 |
| 129. | R² Libræ......... | 15 | 50 | 22 | −17 | 59·7 | 184. | R Capricorni ... | 20 | 5 | 25 | −14 | 34·8 |
| 130. | S Triang. Austr. | 15 | 51 | 45 | −63 | 28·6 | 185. | S Aquilæ......... | 20 | 6 | 47 | +15 | 18·5 |
| 131. | X Herculis ...... | 15 | 59 | 30 | +47 | 31·6 | 186. | X² Cygni......... | 20 | 7 | 36 | +47 | 30·1 |
| 132. | Z Scorpii......... | 15 | 59 | 30 | −21 | 26·8 | 187. | W Capricorni... | 20 | 8 | 18 | −22 | 17·9 |
| 133. | R Herculis ...... | 16 | 1 | 30 | +18 | 39·3 | 188. | R Sagittæ ...... | 20 | 9 | 16 | +16 | 24·5 |
| 134. | X Scorpii ...... | 16 | 2 | 22 | −21 | 14·6 | 189. | R Delphini...... | 20 | 9 | 51 | +8 | 46·2 |
| 135. | W Scorpii ...... | 16 | 5 | 38 | −19 | 51·8 | 190. | U Cygni ......... | 20 | 16 | 21 | +47 | 33·8 |
| 136. | R Scorpii ...... | 16 | 11 | 23 | −22 | 41·1 | 191. | V Cygni ......... | 20 | 37 | 55 | +47 | 46·0 |
| 137. | S Scorpii......... | 16 | 11 | 25 | −22 | 38·0 | 192. | S Delphini ...... | 20 | 38 | 15 | +16 | 42·6 |
| 138. | W Ophiuchi ... | 16 | 15 | 45 | −7 | 26·9 | 193. | X Cygni ......... | 20 | 39 | 18 | +35 | 12·5 |
| 139. | V Ophiuchi ... | 16 | 20 | 53 | −12 | 11·3 | 194. | T Delphini ...... | 20 | 40 | 29 | +16 | 1·0 |
| 140. | U Herculis ...... | 16 | 21 | 10 | +19 | 7·7 | 195. | W Aquarii ...... | 20 | 40 | 54 | −4 | 28·0 |
| 141. | Y Scorpii ...... | 16 | 23 | 32 | −19 | 12·6 | 196. | V Aquarii ...... | 20 | 41 | 31 | +2 | 3·2 |
| 142. | T Ophiuchi...... | 16 | 27 | 41 | −15 | 54·5 | 197. | U Capricorni ... | 20 | 42 | 18 | −15 | 10·2 |
| 143. | S Ophiuchi...... | 16 | 28 | 13 | −16 | 56·4 | 198. | R² Cygni......... | 20 | 42 | 27 | +44 | 29·1 |
| 144. | R Aræ............ | 16 | 31 | 1 | −56 | 47·0 | 199. | V Delphini...... | 20 | 43 | 0 | +18 | 57·0 |
| 145. | W Herculis...... | 16 | 31 | 29 | +37 | 33·3 | 200. | T Aquarii ...... | 20 | 44 | 24 | −5 | 32·2 |
| 146. | Y Herculis ...... | 16 | 31 | 46 | +7 | 19·2 | 201. | T Vulpeculæ ... | 20 | 47 | 1 | +27 | 51·2 |
| 147. | R Draconis ... | 16 | 32 | 23 | +66 | 58·4 | 202. | Y Cygni ......... | 20 | 47 | 53 | +34 | 15·8 |
| 148. | S Herculis ...... | 16 | 47 | 7 | +15 | 7·1 | 203. | R Vulpeculæ ... | 20 | 59 | 43 | +23 | 24·3 |
| 149. | R² Scorpii ...... | 16 | 49 | 56 | −30 | 24·7 | 204. | V Capricorni ... | 21 | 1 | 30 | −24 | 20·8 |
| 150. | R Ophiuchi...... | 17 | 1 | 44 | −15 | 57·1 | 205. | X Capricorni ... | 21 | 2 | 32 | −21 | 46·2 |
| 151. | U Ophiuchi...... | 17 | 11 | 12 | +1 | 19·6 | 206. | T Cephei......... | 21 | 8 | 9 | +68 | 3·8 |
| 152. | Z Ophiuchi...... | 17 | 14 | 13 | +1 | 37·6 | 207. | T Capricorni ... | 21 | 16 | 13 | −15 | 36·1 |
| 153. | X Sagittarii ... | 17 | 40 | 57 | −27 | 47·4 | 208. | Y Capricorni ... | 21 | 28 | 39 | −14 | 26·4 |
| 154. | Y Ophiuchi...... | 17 | 47 | 1 | −6 | 7·0 | 209. | W Cygni......... | 21 | 32 | 5 | +44 | 54·3 |
| 155. | Z Herculis ...... | 17 | 54 | 17 | +15 | 8·6 | 210. | S Cephei ......... | 21 | 36 | 31 | +78 | 9·1 |
| 156. | W Sagittarii ... | 17 | 58 | 19 | −29 | 35·1 | 211. | U² Cygni......... | 21 | 37 | 6 | +53 | 50·9 |
| 157. | T Herculis ...... | 18 | 5 | 8 | +31 | 0·1 | 212. | S Piscis Aust. ... | 21 | 57 | 45 | −28 | 33·5 |
| 158. | Y Sagittarii...... | 18 | 15 | 12 | −18 | 54·4 | 213. | T Pegasi ......... | 22 | 3 | 46 | +12 | 1·6 |
| 159. | T Serpentis...... | 18 | 23 | 41 | +6 | 13·7 | 214. | S Lacertæ ...... | 22 | 24 | 25 | +39 | 46·7 |
| 160. | U Sagittarii ... | 18 | 25 | 42 | −19 | 12·1 | 215. | δ Cephei ......... | 22 | 25 | 16 | +57 | 52·7 |
| 161. | X Ophiuchi ... | 18 | 33 | 21 | +8 | 44·2 | 216. | W Cephei ...... | 22 | 32 | 28 | +57 | 53·1 |
| 162. | R Scuti ......... | 18 | 41 | 53 | −5 | 49·1 | 217. | R Lacertæ ...... | 22 | 38 | 37 | +41 | 49·3 |
| 163. | κ Pavonis ...... | 18 | 46 | 7 | −67 | 21·9 | 218. | S Aquarii ...... | 22 | 51 | 29 | −20 | 54·2 |
| 164. | β Lyræ ......... | 18 | 46 | 12 | +33 | 14·4 | 219. | R Pegasi ......... | 23 | 1 | 23 | +9 | 58·6 |
| 165. | R Lyræ ......... | 18 | 52 | 8 | +43 | 48·4 | 220. | S Pegasi ......... | 23 | 15 | 14 | +8 | 20·7 |
| 166. | R Coron. Austr. | 18 | 54 | 49 | −37 | 6·1 | 221. | R Aquarii ...... | 23 | 38 | 23 | −15 | 52·0 |
| 167. | R Aquilæ ...... | 19 | 1 | 19 | +8 | 4·3 | 222. | V Cephei......... | 23 | 51 | 30 | +82 | 36·4 |
| 168. | T Sagittarii ... | 19 | 10 | 11 | −17 | 9·3 | 223. | V Ceti............ | 23 | 52 | 32 | −9 | 32·7 |
| *169.* | *R Sagittarii* ... | 19 | 10 | 32 | −19 | 29·5 | 224. | R Cassiopeiæ ... | 23 | 53 | 4 | +50 | 48·2 |

## VARIABLES OF SHORT PERIOD NOT OF THE ALGOL TYPE.

(The No. after Star's Name refers to Catalogue on pp. 25–26.)

–The times of minima only are given; the times of maxima may be found by adding the interval printed under the name of the star.

### OCER. 41.

$22\frac{1}{2}^{h}$.)

| May | | Sept. | |
|---|---|---|---|
| d | h | d | h |
| 11 | 9 | 23 | 10 |
| June | | Oct. | |
| 7 | 10 | 20 | 10 |
| July | | Nov. | |
| 4 | 10 | 16 | 10 |
| 1 | 10 | Dec. | |
| Aug. | | 13 | 10 |
| 7 | 10 | | |

### TNOR. 44.

$^{d}\,0^{h}$.)

| Apr. | | Oct. | |
|---|---|---|---|
| d | h | d | h |
| 11 | 2. | 1 | 12 |
| 12 | 1 | 11 | 16 |
| May | | 21 | 20 |
| 2 | 5 | 31 | 23 |
| 12 | 9 | Nov. | |
| 22 | 12 | 11 | 3 |
| Aug. | | 21 | 7 |
| 12 | 17 | Dec. | |
| 21 | 21 | 1 | 10 |
| Sept. | | 11 | 14 |
| 1 | 1 | 21 | 18 |
| 11 | 5 | 31 | 21 |
| 21 | 9 | | |

### IRGINIS 94.

$8^{d}\,5^{h}$.)

| Feb. | | Mar. | |
|---|---|---|---|
| d | h | d | h |
| 10 | 11 | 17 | 0 |
| 27 | 17 | | |

### W VIRGINIS 94

(*continued*).

| Apr. | | July | | Nov. | |
|---|---|---|---|---|---|
| d | h | d | h | d | h |
| 3 | 6 | 15 | 21 | 13 | 9 |
| 20 | 13 | Aug. | | Dec. | |
| May | | 2 | 4 | 1 | 1 |
| 7 | 19 | 19 | 10 | 18 | 8 |
| 25 | 2 | Oct. | | | |
| June | | 10 | 6 | | |
| 11 | 8 | 27 | 12 | | |
| 28 | 15 | | | | |

### X SAGITTAR. 153.

($2^{d}\,21^{h}$.)

| Feb. | | May | | Aug. | |
|---|---|---|---|---|---|
| d | h | d | h | d | h |
| 4 | 0 | 13 | 4 | 19 | 8 |
| 11 | 1 | 20 | 5 | 26 | 9 |
| 18 | 1 | 27 | 5 | Sept. | |
| 25 | 1 | | | 2 | 9 |
| Mar. | | June | | 9 | 9 |
| 4 | 2 | 3 | 5 | 16 | 10 |
| 11 | 2 | 10 | 6 | 23 | 10 |
| 18 | 2 | 17 | 6 | 30 | 10 |
| 25 | 2 | 24 | 6 | Oct. | |
| Apr. | | July | | 7 | 10 |
| 1 | 3 | 1 | 6 | 14 | 11 |
| 8 | 3 | 8 | 7 | 21 | 11 |
| 15 | 3 | 15 | 7 | 28 | 11 |
| 22 | 4 | 22 | 7 | Nov. | |
| 29 | 4 | 29 | 8 | 4 | 12 |
| May | | Aug. | | 11 | 12 |
| | | 5 | 8 | 18 | 12 |
| 6 | 4 | 12 | 8 | 25 | 12 |

### Y OPHIUCHI 154.

($6^{d}\,6^{h}$.)

| Jan. | | Apr. | | Aug. | |
|---|---|---|---|---|---|
| d | h | d | h | d | h |
| 14 | 9 | 10 | 0 | 7 | 21 |
| 31 | 12 | 27 | 3 | 25 | 0 |
| Feb. | | May. | | Sept. | |
| 17 | 15 | 14 | 6 | 11 | 3 |
| Mar. | | 31 | 9 | 28 | 6 |
| 6 | 18 | June | | Oct. | |
| 23 | 21 | 17 | 12 | 15 | 9 |
| | | July | | | |
| | | 4 | 15 | | |
| | | 21 | 18 | | |

### W SAGITTAR. 156.

($3^{d}\,0^{h}$.)

| Feb. | | May | | Aug. | |
|---|---|---|---|---|---|
| d | h | d | h | d | h |
| 10 | 21 | 20 | 14 | 19 | 18 |
| 18 | 11 | 28 | 5 | 27 | 8 |
| 26 | 1 | | | Sept. | |
| | | June | | 3 | 22 |
| Mar. | | 4 | 19 | 11 | 12 |
| 5 | 16 | 12 | 9 | 19 | 3 |
| 13 | 6 | 19 | 23 | 26 | 17 |
| 20 | 20 | 27 | 14 | Oct. | |
| 28 | 10 | | | 4 | 7 |
| Apr. | | July | | 11 | 22 |
| 5 | 1 | 5 | 4 | 19 | 12 |
| 12 | 15 | 12 | 18 | 27 | 2 |
| 20 | 5 | 20 | 9 | Nov. | |
| 27 | 20 | 27 | 23 | 3 | 16 |
| May | | Aug. | | 11 | 7 |
| 5 | 10 | 4 | 13 | 18 | 21 |
| 13 | 0 | 12 | 3 | 26 | 11 |

### Y SAGITTAR. 158.

($1^{d}\,19^{h}$.)

| Feb. | | May | | Aug. | |
|---|---|---|---|---|---|
| d | h | d | h | d | h |
| 2 | | 17 | 4 | 23 | 7 |
| 8 | 1 | 22 | 23 | 29 | 2 |
| 13 | 19 | 28 | 17 | Sept. | |
| 19 | 14 | June | | 3 | 21 |
| 25 | 8 | 3 | 12 | 9 | 15 |
| Mar. | | 9 | 6 | 15 | 10 |
| 3 | 3 | 15 | 1 | 21 | 4 |
| 8 | 21 | 20 | 19 | 26 | 23 |
| 14 | 16 | 26 | 14 | Oct. | |
| 20 | 10 | July | | 2 | 17 |
| 26 | 5 | 2 | 8 | 8 | 12 |
| Apr. | | 8 | 3 | 14 | 6 |
| 1 | 0 | 13 | 22 | 20 | 1 |
| 6 | 18 | 19 | 16 | 25 | 20 |
| 12 | 13 | 25 | 11 | 31 | 14 |
| 18 | 7 | 31 | 5 | Nov. | |
| 24 | 2 | | | 6 | 9 |
| 29 | 20 | Aug. | | 12 | 3 |
| May | | 6 | 0 | 17 | 22 |
| 5 | 15 | 11 | 18 | 23 | 16 |
| 11 | 9 | 17 | 13 | 29 | 11 |

### U SAGITTAR. 160.

($2^{d}\,23^{h}$.)

| Feb. | | Apr. | | June | |
|---|---|---|---|---|---|
| d | h | d | h | d | h |
| 7 | 14 | 2 | 13 | 2 | 6 |
| 14 | 8 | 9 | 7 | 9 | 0 |
| 21 | 2 | 16 | 1 | 15 | 18 |
| 27 | 20 | 22 | 19 | 22 | 12 |
| | | 29 | 13 | 29 | 5 |
| Mar. | | May | | July | |
| 6 | 14 | 6 | 6 | 5 | 23 |
| 13 | 7 | 13 | 0 | 12 | 17 |
| 20 | 1 | 19 | 18 | 19 | 11 |
| 26 | 19 | 26 | 12 | 26 | 5 |

### U SAGITTAR. 160.

(*continued*).

| Aug. | | Sept. | | Oct. | |
|---|---|---|---|---|---|
| d | h | d | h | d | h |
| 1 | 23 | 11 | 10 | 21 | 21 |
| 8 | 17 | 18 | 4 | 28 | 15 |
| 15 | 10 | 24 | 22 | Nov. | |
| 22 | 4 | Oct. | | 4 | 9 |
| 28 | 22 | 1 | 16 | 11 | 3 |
| Sept. | | 8 | 9 | 17 | 21 |
| 4 | 16 | 15 | 3 | 24 | 15 |

### β LYRÆ 164.

(Max. $3^{d}\,5^{h}$.

Secondary Min.

$6^{d}\,11^{h}$.

Max. $9^{d}\,16^{h}$.)

| Jan. | | May | | Sept. | |
|---|---|---|---|---|---|
| d | h | d | h | d | h |
| 13 | 3 | 9 | 8 | 2 | 14 |
| 26 | 1 | 22 | 6 | 15 | 12 |
| | | | | 28 | 10 |
| Feb. | | June | | Oct. | |
| 7 | 23 | 4 | 4 | 11 | 8 |
| 20 | 21 | 17 | 2 | 24 | 6 |
| Mar. | | 30 | 0 | Nov. | |
| 5 | 19 | July | | 6 | 4 |
| 18 | 17 | 12 | 22 | 19 | 2 |
| 31 | 15 | 25 | 20 | Dec. | |
| Apr. | | Aug. | | 2 | 0 |
| 13 | 13 | 7 | 18 | 14 | 22 |
| 26 | 11 | 20 | 16 | 27 | 20 |

## VARIABLES OF SHORT PERIOD (*continued*).

### U AQUILÆ 173.

($2^d\ 3^h$.)

| | d | h |
|---|---|---|
| Feb. | 19 | 21 |
| | 26 | 21 |
| Mar. | 5 | 22 |
| | 12 | 22 |
| | 19 | 23 |
| | 27 | 0 |
| Apr. | 3 | 0 |
| | 10 | 1 |
| | 17 | 1 |
| | 24 | 2 |
| May | 1 | 3 |
| | 8 | 3 |
| | 15 | 4 |

| | d | h |
|---|---|---|
| May | 22 | 5 |
| | 29 | 5 |
| June | 5 | 6 |
| | 12 | 6 |
| | 19 | 7 |
| | 26 | 8 |
| July | 3 | 8 |
| | 10 | 9 |
| | 17 | 9 |
| | 24 | 10 |
| | 31 | 11 |
| Aug. | 7 | 11 |
| | 14 | 12 |
| | 21 | 12 |
| | 28 | 13 |

| | d | h |
|---|---|---|
| Sept. | 4 | 14 |
| | 11 | 14 |
| | 18 | 15 |
| | 25 | 15 |
| Oct. | 2 | 16 |
| | 9 | 17 |
| | 16 | 17 |
| | 23 | 18 |
| | 30 | 19 |
| Nov. | 6 | 19 |
| | 13 | 20 |
| | 20 | 20 |
| | 27 | 21 |
| Dec. | 4 | 22 |

### η AQUILÆ 179.

($2^d\ 9^h$.)

| | d | h |
|---|---|---|
| Feb. | 6 | 20 |
| | 14 | 0 |

| | d | h |
|---|---|---|
| Feb. | 21 | 4 |
| | 28 | 9 |

| | d | h |
|---|---|---|
| Mar. | 7 | 13 |
| | 14 | 17 |

### η AQUILÆ 179 (*continued*).

| | d | h |
|---|---|---|
| Mar. | 21 | 21 |
| | 29 | 2 |
| Apr. | 5 | 6 |
| | 12 | 10 |
| | 19 | 14 |
| | 26 | 18 |
| May | 3 | 23 |
| | 11 | 3 |
| | 18 | 7 |
| | 25 | 11 |
| June | 1 | 16 |
| | 8 | 20 |
| | 16 | 0 |

| | d | h |
|---|---|---|
| June | 23 | 4 |
| | 30 | 9 |
| July | 7 | 13 |
| | 14 | 17 |
| | 21 | 21 |
| | 29 | 2 |
| Aug. | 5 | 6 |
| | 12 | 10 |
| | 19 | 14 |
| | 26 | 18 |
| Sept. | 2 | 23 |
| | 10 | 3 |
| | 17 | 7 |

| | d | h |
|---|---|---|
| Sept. | 24 | 11 |
| Oct. | 1 | 16 |
| | 8 | 20 |
| | 16 | 0 |
| | 23 | 4 |
| | 30 | 9 |
| Nov. | 6 | 13 |
| | 13 | 17 |
| | 20 | 21 |
| | 28 | 1 |
| Dec. | 5 | 6 |
| | 12 | 10 |
| | 19 | 14 |
| | 26 | 18 |

### S SAGITTÆ 181.

($3^d\ 10^h$.)

| | d | h |
|---|---|---|
| Feb. | 5 | 8 |
| | 13 | 17 |
| | 22 | 2 |

| | d | h |
|---|---|---|
| Mar. | 2 | 11 |
| | 10 | 20 |
| | 19 | 6 |
| | 27 | 15 |

| | d | h |
|---|---|---|
| Apr. | 5 | 0 |
| | 13 | 9 |
| | 21 | 18 |
| | 30 | 4 |

### S SAGITTÆ 181 (*continued*).

| | d | h |
|---|---|---|
| May | 8 | 13 |
| | 16 | 22 |
| | 25 | 7 |
| June | 2 | 16 |
| | 11 | 2 |
| | 19 | 11 |
| | 27 | 20 |
| July | 6 | 5 |
| | 14 | 14 |

| | d | h |
|---|---|---|
| July | 23 | 0 |
| | 31 | 9 |
| Aug. | 8 | 18 |
| | 17 | 3 |
| | 25 | 12 |
| Sept. | 2 | 22 |
| | 11 | 7 |
| | 19 | 16 |
| | 28 | 1 |

| | d | h |
|---|---|---|
| Oct. | 6 | 10 |
| | 14 | 20 |
| | 23 | 5 |
| | 31 | 14 |
| Nov. | 8 | 23 |
| | 17 | 8 |
| | 25 | 18 |
| Dec. | 4 | 3 |
| | 12 | 12 |

### X CYGNI 193.

($6^d\ 19^h$.)

| | d | h |
|---|---|---|
| Jan. | 5 | 8 |
| | 21 | 17 |
| Feb. | 7 | 3 |
| | 23 | 12 |
| Mar. | 11 | 21 |
| | 28 | 7 |
| Apr. | 13 | 16 |
| | 30 | 1 |

| | d | h |
|---|---|---|
| May | 16 | 11 |
| June | 1 | 20 |
| | 18 | 5 |
| July | 4 | 15 |
| | 21 | 0 |
| Aug. | 6 | 9 |
| | 22 | 19 |

| | d | h |
|---|---|---|
| Sept. | 8 | 4 |
| | 24 | 13 |
| Oct. | 10 | 23 |
| | 27 | 8 |
| Nov. | 12 | 17 |
| | 29 | 3 |
| Dec. | 15 | 12 |
| | 31 | 21 |

### T VULPEC. 201.

($1^d\ 7^h$.)

| | d | h |
|---|---|---|
| Jan. | 3 | 0 |
| | 7 | 10 |
| | 11 | 21 |
| | 16 | 7 |
| | 20 | 18 |
| | 25 | 4 |
| | 29 | 15 |
| Feb. | 3 | 1 |
| | 7 | 11 |
| | 11 | 22 |
| | 16 | 8 |
| | 20 | 19 |
| | 25 | 5 |
| Mar. | 1 | 16 |
| | 6 | 2 |
| | 10 | 13 |
| | 14 | 23 |
| | 19 | 10 |
| | 23 | 20 |
| | 28 | 7 |
| Apr. | 1 | 17 |
| | 6 | 4 |
| | 10 | 14 |
| | 15 | 0 |
| | 19 | 11 |
| | 23 | 21 |
| | 28 | 8 |

| | d | h |
|---|---|---|
| May | 2 | 18 |
| | 7 | 5 |
| | 11 | 15 |
| | 16 | 2 |
| | 20 | 12 |
| | 24 | 23 |
| | 29 | 9 |
| June | 2 | 20 |
| | 7 | 6 |
| | 11 | 17 |
| | 16 | 3 |
| | 20 | 14 |
| | 25 | 0 |
| | 29 | 10 |
| July | 3 | 21 |
| | 8 | 7 |
| | 12 | 18 |
| | 17 | 4 |
| | 21 | 15 |
| | 26 | 1 |
| | 30 | 12 |
| Aug. | 3 | 22 |
| | 8 | 9 |
| | 12 | 19 |
| | 17 | 6 |
| | 21 | 16 |
| | 26 | 3 |
| | 30 | 13 |

| | d | h |
|---|---|---|
| Sept. | 3 | 23 |
| | 8 | 10 |
| | 12 | 20 |
| | 17 | 7 |
| | 21 | 17 |
| | 26 | 4 |
| | 30 | 14 |
| Oct. | 5 | 1 |
| | 9 | 11 |
| | 13 | 22 |
| | 18 | 8 |
| | 22 | 19 |
| | 27 | 5 |
| | 31 | 16 |
| Nov. | 5 | 2 |
| | 9 | 13 |
| | 13 | 23 |
| | 18 | 9 |
| | 22 | 20 |
| | 27 | 6 |
| Dec. | 1 | 17 |
| | 6 | 3 |
| | 10 | 14 |
| | 15 | 0 |
| | 19 | 11 |
| | 23 | 21 |
| | 28 | 8 |

### δ CEPHE

($1^d$ 15

| | d | h |
|---|---|---|
| Jan. | 3 | 5 |
| | 8 | 14 |
| | 13 | 23 |
| | 19 | 8 |
| | 24 | 16 |
| | 30 | 1 |
| Feb. | 4 | 10 |
| | 9 | 19 |
| | 15 | 4 |
| | 20 | 12 |
| | 25 | 21 |
| Mar. | 3 | 6 |
| | 8 | 15 |
| | 13 | 23 |
| | 19 | 8 |
| | 24 | 17 |
| | 30 | 2 |
| Apr. | 4 | 11 |
| | 9 | 19 |
| | 15 | 4 |
| | 20 | 13 |
| | 25 | 22 |

| | d | |
|---|---|---|
| May | 1 | |
| | 6 | |
| | 12 | |
| | 17 | |
| | 22 | |
| | 28 | |
| Jun | 2 | |
| | 7 | |
| | 13 | |
| | 18 | |
| | 23 | |
| | 29 | |
| July | 4 | |
| | 10 | |
| | 15 | |
| | 20 | |
| | 26 | |
| | 31 | |
| Aug. | 5 | |
| | 11 | |
| | 16 | |
| | 21 | |
| | 27 | |

## MAGNETIC ELEMENTS, ROYAL OBSERVATORY, GREENWICH.

| Year. | Declination. | Horizontal force. | Dip. |
|---|---|---|---|
| | ° ′ | | ° ′ |
| 1870, observed ......... | 19 53 west. | 0·1782 | 67 52 |
| 1880, „ ......... | 18 33 „ | 0·1804 | 67 36 |
| 1890, „ ......... | 17 29 „ | 0·1823 | 67 23 |
| 1895, inferred ......... | 17 0 „ | 0·1832 | 67 16 |

*The horizontal force is given in C. G. S. measure.*

# MINIMA OF VARIABLE STARS OF THE ALGOL TYPE.

(The figures following star's name are the Nos. in Catalogue, pp. 25–26.)

## U CEPHEI 7 *.

($2^d\ 11^h\ 50^m$.)

| | d | h | m |
|---|---|---|---|
| Jan. | 1 | 3 | 32 |
| | 6 | 3 | 11 |
| | 11 | 2 | 50 |
| | 16 | 2 | 30 |
| | 21 | 2 | 9 |
| | 26 | 1 | 48 |
| | 31 | 1 | 27 |
| Feb. | 5 | 1 | 7 |
| | 10 | 0 | 46 |
| | 15 | 0 | 25 |
| | 20 | 0 | 4 |
| | 24 | 23 | 44 |
| March. | 1 | 23 | 23 |
| | 6 | 23 | 2 |
| | 11 | 22 | 41 |
| | 16 | 22 | 20 |
| | 21 | 22 | 0 |
| | 26 | 22 | 39 |
| | 31 | 21 | 18 |
| April. | 5 | 20 | 58 |
| | 10 | 20 | 37 |
| | 15 | 20 | 16 |
| | 20 | 19 | 55 |
| | 25 | 19 | 35 |
| | 30 | 19 | 14 |
| May. | 5 | 18 | 53 |
| | 10 | 18 | 32 |
| | 15 | 18 | 12 |
| | 20 | 17 | 51 |
| | 25 | 17 | 30 |
| | 30 | 17 | 9 |
| June. | 4 | 16 | 48 |
| | 9 | 16 | 28 |
| | 14 | 16 | 7 |
| | 19 | 15 | 46 |
| | 24 | 15 | 25 |
| | 29 | 15 | 5 |
| July. | 4 | 14 | 44 |
| | 9 | 14 | 23 |
| | 14 | 14 | 2 |
| | 19 | 13 | 42 |
| | 24 | 13 | 21 |
| | 29 | 13 | 0 |
| August. | 3 | 12 | 39 |
| | 8 | 12 | 19 |
| | 13 | 11 | 58 |
| | 18 | 11 | 37 |
| | 23 | 11 | 16 |
| | 28 | 10 | 55 |
| Sept. | 2 | 10 | 35 |
| | 7 | 10 | 14 |
| | 12 | 9 | 53 |
| | 17 | 9 | 32 |
| | 22 | 9 | 12 |
| | 27 | 8 | 51 |
| Oct. | 2 | 8 | 30 |
| | 7 | 8 | 9 |
| | 12 | 7 | 48 |
| | 17 | 7 | 28 |
| | 22 | 7 | 7 |
| | 27 | 6 | 46 |
| Nov. | 1 | 6 | 25 |
| | 6 | 6 | 4 |
| | 11 | 5 | 44 |
| | 16 | 5 | 23 |
| | 21 | 5 | 2 |
| | 26 | 4 | 41 |
| Dec. | 1 | 4 | 21 |
| | 6 | 4 | 0 |
| | 11 | 3 | 39 |
| | 16 | 3 | 18 |
| | 21 | 2 | 58 |
| | 26 | 2 | 37 |
| | 31 | 2 | 16 |

## ALGOL 20 *.

($2^d\ 20^h\ 49^m$.)

| | d | h | m |
|---|---|---|---|
| Jan. | 3 | 20 | 28 |
| | 9 | 14 | 6 |
| | 15 | 7 | 44 |
| | 21 | 1 | 22 |
| | 26 | 19 | 0 |
| Feb. | 1 | 12 | 37 |
| | 7 | 6 | 15 |
| | 12 | 23 | 53 |
| | 18 | 17 | 31 |
| | 24 | 11 | 8 |
| March. | 2 | 4 | 46 |
| | 7 | 22 | 24 |
| | 13 | 16 | 2 |
| | 19 | 9 | 39 |
| | 25 | 3 | 17 |
| | 30 | 20 | 55 |
| April. | 5 | 14 | 33 |
| | 11 | 8 | 10 |
| | 17 | 1 | 48 |
| | 22 | 19 | 26 |
| | 28 | 13 | 4 |
| June. | 19 | 3 | 43 |
| | 24 | 21 | 21 |
| | 30 | 14 | 59 |
| July. | 6 | 8 | 37 |
| | 12 | 2 | 14 |
| | 17 | 19 | 52 |
| | 23 | 13 | 30 |
| | 29 | 7 | 8 |
| August. | 4 | 0 | 45 |
| | 9 | 18 | 23 |
| | 15 | 12 | 1 |
| | 21 | 5 | 39 |
| | 26 | 23 | 16 |
| Sept. | 1 | 16 | 54 |
| | 7 | 10 | 32 |
| | 13 | 4 | 10 |
| | 18 | 21 | 47 |
| | 24 | 15 | 25 |
| | 30 | 9 | 3 |
| Oct. | 6 | 2 | 41 |
| | 11 | 20 | 18 |
| | 17 | 13 | 56 |
| | 23 | 7 | 34 |
| | 29 | 1 | 12 |
| Nov. | 3 | 18 | 49 |
| | 9 | 12 | 27 |
| | 15 | 6 | 5 |
| | 20 | 23 | 43 |
| | 26 | 17 | 20 |
| Dec. | 2 | 10 | 58 |
| | 8 | 4 | 36 |
| | 13 | 22 | 14 |
| | 19 | 15 | 51 |
| | 25 | 9 | 29 |
| | 31 | 3 | 7 |

## λ TAURI 23 *.

($3^d\ 22^h\ 52^m$.)

| | d | h | m |
|---|---|---|---|
| Jan. | 3 | 16 | 56 |
| | 11 | 14 | 41 |
| | 19 | 12 | 25 |
| | 27 | 10 | 9 |
| Feb. | 4 | 7 | 54 |
| | 12 | 5 | 38 |
| | 20 | 3 | 23 |
| | 28 | 1 | 7 |
| March. | 7 | 22 | 51 |
| | 15 | 20 | 36 |
| | 23 | 18 | 20 |
| | 31 | 16 | 5 |
| July. | 4 | 12 | 57 |
| | 12 | 10 | 42 |
| | 20 | 8 | 26 |
| | 28 | 6 | 11 |

## λ TAURI 23 *.

(*continued*).

| | d | h | m |
|---|---|---|---|
| August. | 5 | 3 | 55 |
| | 13 | 1 | 39 |
| | 20 | 23 | 24 |
| | 28 | 21 | 8 |
| Sept. | 5 | 18 | 53 |
| | 13 | 16 | 37 |
| | 21 | 14 | 21 |
| | 29 | 12 | 6 |
| Oct. | 7 | 9 | 50 |
| | 15 | 7 | 35 |
| | 23 | 5 | 19 |
| | 31 | 3 | 3 |
| Nov. | 8 | 0 | 48 |
| | 15 | 22 | 32 |
| | 23 | 20 | 17 |
| Dec. | 1 | 18 | 1 |
| | 9 | 15 | 45 |
| | 17 | 13 | 30 |
| | 25 | 11 | 14 |

## R CANIS MAJ. 48†.

$\left\{\begin{array}{l} 1 = 1^d\ 3^h\ 16^m. \\ 2 = 2\ \ 6\ \ 31 \end{array}\right\}$

| | d | h | m |
|---|---|---|---|
| Jan. | 1 | 5 | 43 |
| | 4 | 15 | 31 |
| | 8 | 1 | 18 |
| | 11 | 11 | 5 |
| | 14 | 20 | 52 |
| | 18 | 6 | 40 |
| | 21 | 16 | 27 |
| | 25 | 2 | 15 |
| | 28 | 12 | 2 |
| | 31 | 21 | 49 |
| Feb. | 4 | 7 | 36 |
| | 7 | 17 | 24 |
| | 11 | 3 | 11 |
| | 14 | 12 | 58 |
| | 17 | 22 | 46 |
| | 21 | 8 | 33 |
| | 24 | 18 | 20 |
| | 28 | 4 | 8 |
| March. | 3 | 13 | 55 |
| | 6 | 23 | 42 |
| | 10 | 9 | 29 |
| | 13 | 19 | 17 |
| | 17 | 5 | 4 |
| | 20 | 14 | 51 |
| | 24 | 0 | 39 |
| | 27 | 10 | 26 |
| | 30 | 20 | 13 |
| April. | 3 | 6 | 1 |
| | 6 | 15 | 48 |
| | 10 | 1 | 35 |
| | 13 | 11 | 22 |
| | 16 | 21 | 10 |
| | 20 | 6 | 57 |
| | 23 | 16 | 44 |
| | 27 | 2 | 32 |
| | 30 | 12 | 19 |
| May. | 3 | 22 | 6 |
| | 7 | 7 | 54 |
| | 10 | 17 | 41 |
| | 14 | 3 | 28 |
| | 17 | 13 | 15 |
| | 20 | 23 | 3 |
| | 24 | 8 | 50 |
| | 27 | 18 | 37 |

* Alternate minima only are given; the others can be readily found by adding the interval under the name of the star.

† Every third *minimum only.*

## *Minima of Variable Stars of the Algol Type* (continued).

### R Canis Maj. 48†
(*continued*).

Sept.

| d | h | m |
|---|---|---|
| 3 | 14 | 29 |
| 7 | 0 | 16 |
| 10 | 10 | 4 |
| 13 | 19 | 51 |
| 17 | 5 | 38 |
| 20 | 15 | 26 |
| 24 | 1 | 13 |
| 27 | 11 | 0 |
| 30 | 20 | 47 |

Oct.

| d | h | m |
|---|---|---|
| 4 | 6 | 35 |
| 7 | 16 | 22 |
| 11 | 2 | 9 |
| 14 | 11 | 57 |
| 17 | 21 | 44 |
| 21 | 7 | 31 |
| 24 | 17 | 19 |
| 28 | 3 | 6 |
| 31 | 12 | 53 |

Nov.

| d | h | m |
|---|---|---|
| 3 | 22 | 40 |
| 7 | 8 | 28 |
| 10 | 18 | 15 |
| 14 | 4 | 2 |
| 17 | 13 | 50 |
| 20 | 23 | 37 |
| 24 | 9 | 24 |
| 27 | 19 | 12 |

Dec.

| d | h | m |
|---|---|---|
| 1 | 4 | 59 |
| 4 | 14 | 46 |
| 8 | 0 | 33 |
| 11 | 10 | 21 |
| 14 | 20 | 8 |
| 18 | 5 | 55 |
| 21 | 15 | 43 |
| 25 | 1 | 30 |
| 28 | 11 | 17 |
| 31 | 21 | 5 |

### S Cancri 63.

Jan.

| d | h | m |
|---|---|---|
| 3 | 19 | 34 |
| 13 | 7 | 12 |
| 22 | 18 | 49 |

Feb.

| d | h | m |
|---|---|---|
| 1 | 6 | 27 |
| 10 | 18 | 5 |
| 20 | 5 | 45 |

March.

| d | h | m |
|---|---|---|
| 1 | 17 | 20 |
| 11 | 4 | 58 |
| 20 | 16 | 36 |
| 30 | 4 | 14 |

April.

| d | h | m |
|---|---|---|
| 8 | 15 | 51 |
| 18 | 3 | 29 |
| 27 | 15 | 7 |

May.

| d | h | m |
|---|---|---|
| 7 | 2 | 45 |
| 16 | 14 | 22 |
| 26 | 2 | 0 |

June.

| d | h | m |
|---|---|---|
| 4 | 13 | 38 |
| 14 | 1 | 16 |
| 23 | 12 | 53 |

July.

| d | h | m |
|---|---|---|
| 3 | 0 | 31 |
| 12 | 12 | 9 |
| 21 | 23 | 47 |
| 31 | 11 | 24 |

Sept.

| d | h | m |
|---|---|---|
| 7 | 9 | 55 |
| 16 | 21 | 33 |
| 26 | 9 | 11 |

Oct.

| d | h | m |
|---|---|---|
| 5 | 20 | 49 |
| 15 | 8 | 26 |
| 24 | 20 | 4 |

Nov.

| d | h | m |
|---|---|---|
| 3 | 7 | 42 |
| 12 | 19 | 20 |
| 22 | 6 | 57 |

Dec.

| d | h | m |
|---|---|---|
| 1 | 18 | 35 |
| 11 | 6 | 13 |
| 20 | 17 | 51 |
| 30 | 5 | 28 |

### δ Libræ 112*.
($2^d\ 7^h\ 51^m$.)

Jan.

| d | h | m |
|---|---|---|
| 2 | 4 | 16 |
| 6 | 19 | 59 |
| 11 | 11 | 42 |
| 16 | 3 | 25 |
| 20 | 19 | 7 |
| 25 | 10 | 50 |
| 30 | 2 | 33 |

Feb.

| d | h | m |
|---|---|---|
| 3 | 18 | 16 |
| 8 | 9 | 58 |
| 13 | 1 | 41 |
| 17 | 17 | 24 |
| 22 | 9 | 7 |
| 27 | 0 | 49 |

March.

| d | h | m |
|---|---|---|
| 3 | 16 | 32 |
| 8 | 8 | 15 |
| 12 | 23 | 58 |
| 17 | 15 | 40 |
| 22 | 7 | 23 |
| 26 | 23 | 6 |
| 31 | 14 | 49 |

April.

| d | h | m |
|---|---|---|
| 5 | 6 | 31 |
| 9 | 22 | 14 |
| 14 | 13 | 57 |
| 19 | 5 | 40 |
| 26 | 5 | 14 |
| 30 | 20 | 57 |

May.

| d | h | m |
|---|---|---|
| 5 | 12 | 39 |
| 10 | 4 | 22 |
| 14 | 19 | 55 |
| 19 | 11 | 48 |
| 24 | 3 | 30 |
| 28 | 19 | 13 |

June.

| d | h | m |
|---|---|---|
| 2 | 10 | 56 |
| 7 | 2 | 39 |
| 11 | 18 | 22 |
| 16 | 10 | 4 |
| 21 | 1 | 47 |
| 25 | 17 | 30 |
| 30 | 9 | 13 |

July.

| d | h | m |
|---|---|---|
| 5 | 0 | 55 |
| 9 | 16 | 38 |
| 14 | 8 | 21 |
| 19 | 0 | 4 |
| 23 | 15 | 46 |
| 28 | 7 | 29 |

August.

| d | h | m |
|---|---|---|
| 1 | 23 | 12 |
| 6 | 14 | 55 |
| 11 | 6 | 37 |
| 15 | 22 | 20 |
| 20 | 14 | 3 |
| 25 | 5 | 46 |
| 29 | 21 | 28 |

Sept.

| d | h | m |
|---|---|---|
| 3 | 13 | 11 |
| 8 | 4 | 54 |
| 12 | 20 | 37 |
| 17 | 12 | 19 |
| 22 | 4 | 2 |
| 26 | 19 | 45 |

Dec.

| d | h | m |
|---|---|---|
| 3 | 7 | 35 |
| 7 | 23 | 18 |
| 12 | 15 | 1 |
| 17 | 6 | 43 |
| 21 | 22 | 26 |
| 26 | 14 | 9 |
| 31 | 5 | 52 |

### U Coronæ 117*.
($3^d\ 10^h\ 51^m$.)

Jan.

| d | h | m |
|---|---|---|
| 1 | 14 | 5 |
| 8 | 11 | 48 |
| 15 | 9 | 30 |
| 22 | 7 | 12 |
| 29 | 4 | 54 |

Feb.

| d | h | m |
|---|---|---|
| 5 | 2 | 36 |
| 12 | 0 | 18 |
| 18 | 22 | 0 |
| 25 | 19 | 42 |

### U Coronæ 117*
(*continued*).

March.

| d | h | m |
|---|---|---|
| 4 | 17 | 24 |
| 11 | 15 | 6 |
| 18 | 12 | 49 |
| 25 | 10 | 31 |

April.

| d | h | m |
|---|---|---|
| 1 | 8 | 13 |
| 8 | 5 | 55 |
| 15 | 3 | 37 |
| 22 | 1 | 19 |
| 28 | 23 | 1 |

May.

| d | h | m |
|---|---|---|
| 5 | 20 | 43 |
| 12 | 18 | 25 |
| 19 | 16 | 7 |
| 26 | 13 | 49 |

June.

| d | h | m |
|---|---|---|
| 2 | 11 | 32 |
| 9 | 9 | 14 |
| 16 | 6 | 56 |
| 23 | 4 | 38 |
| 30 | 2 | 20 |

July.

| d | h | m |
|---|---|---|
| 7 | 0 | 2 |
| 13 | 21 | 44 |
| 20 | 19 | 26 |
| 27 | 17 | 8 |

August.

| d | h | m |
|---|---|---|
| 3 | 14 | 50 |
| 10 | 12 | 32 |
| 17 | 10 | 15 |
| 24 | 7 | 57 |
| 31 | 5 | 39 |

Sept.

| d | h | m |
|---|---|---|
| 7 | 3 | 21 |
| 14 | 1 | 3 |
| 20 | 22 | 45 |
| 27 | 20 | 27 |

Oct.

| d | h | m |
|---|---|---|
| 4 | 18 | 9 |
| 11 | 15 | 51 |
| 18 | 13 | 33 |
| 25 | 11 | 51 |

Nov.

| d | h | m |
|---|---|---|
| 1 | 8 | 58 |
| 8 | 6 | 40 |
| 15 | 4 | 22 |
| 22 | 2 | 4 |
| 28 | 23 | 46 |

Dec.

| d | h | m |
|---|---|---|
| 5 | 21 | 28 |
| 12 | 19 | 10 |
| 19 | 16 | 52 |
| 26 | 14 | 34 |

### U Ophiuchi 151‡.

$$\left\{\begin{array}{l} 1 = 0^d\ 20^h\ 8^m \\ 2 = 1\ \ 16\ \ 16 \\ 3 = 2\ \ 12\ \ 23 \end{array}\right\}$$

Jan.

| d | h | m |
|---|---|---|
| 1 | 2 | 30 |
| 4 | 11 | 1 |
| 7 | 19 | 31 |
| 11 | 4 | 2 |
| 14 | 12 | 33 |
| 17 | 21 | 4 |
| 21 | 5 | 35 |
| 24 | 14 | 6 |
| 27 | 22 | 37 |
| 31 | 7 | 7 |

Feb.

| d | h | m |
|---|---|---|
| 3 | 15 | 38 |
| 7 | 0 | 9 |
| 10 | 8 | 40 |
| 13 | 17 | 11 |
| 17 | 2 | 42 |
| 20 | 10 | 12 |
| 23 | 18 | 43 |
| 27 | 3 | 14 |

March.

| d | h | m |
|---|---|---|
| 2 | 11 | 45 |
| 5 | 20 | 16 |
| 9 | 4 | 47 |
| 12 | 13 | 18 |
| 15 | 21 | 48 |
| 19 | 6 | 19 |
| 22 | 14 | 50 |
| 25 | 23 | 21 |
| 29 | 7 | 52 |

---

* Alternate minima only are given; the others can be readily found by adding the interval under the name of the star.

† Every third minimum only.

‡ *Every fourth* minimum only.

## *Minima of Variable Stars of the Algol Type* (continued).

### U Ophiuchi 151 ‡ (*continued*).

| | d | h | m |
|---|---|---|---|
| April. | 1 | 16 | 23 |
| | 5 | 0 | 53 |
| | 8 | 9 | 24 |
| | 11 | 17 | 55 |
| | 15 | 2 | 26 |
| | 18 | 10 | 57 |
| | 21 | 19 | 28 |
| | 25 | 3 | 59 |
| | 27 | 12 | 29 |
| May. | 1 | 0 | 53 |
| | 4 | 9 | 23 |
| | 7 | 17 | 54 |
| | 11 | 2 | 25 |
| | 14 | 10 | 56 |
| | 17 | 19 | 27 |
| | 21 | 3 | 58 |
| | 24 | 12 | 28 |
| | 27 | 20 | 59 |
| | 31 | 5 | 30 |
| June. | 3 | 14 | 1 |
| | 6 | 22 | 32 |
| | 10 | 7 | 3 |
| | 13 | 15 | 34 |
| | 17 | 0 | 4 |
| | 20 | 8 | 35 |
| | 23 | 17 | 6 |
| | 27 | 1 | 37 |
| | 30 | 10 | 8 |
| July. | 3 | 18 | 39 |
| | 7 | 3 | 10 |
| | 10 | 11 | 40 |
| | 13 | 20 | 11 |
| | 17 | 4 | 42 |
| | 20 | 13 | 13 |
| | 23 | 21 | 44 |
| | 27 | 6 | 15 |
| | 30 | 14 | 45 |
| August. | 2 | 23 | 16 |
| | 6 | 7 | 47 |
| | 9 | 16 | 18 |
| | 13 | 0 | 49 |
| | 16 | 9 | 20 |
| | 19 | 17 | 51 |
| | 23 | 2 | 21 |
| | 26 | 10 | 52 |
| | 29 | 19 | 23 |
| Sept. | 2 | 3 | 54 |
| | 5 | 12 | 25 |
| | 8 | 20 | 56 |
| | 12 | 5 | 27 |
| | 15 | 13 | 57 |
| | 18 | 22 | 28 |
| | 22 | 6 | 59 |
| | 25 | 15 | 30 |
| | 29 | 0 | 1 |
| Oct. | 2 | 8 | 32 |
| | 5 | 17 | 3 |
| | 9 | 1 | 33 |
| | 12 | 10 | 4 |
| | 15 | 18 | 35 |
| | 19 | 3 | 6 |
| | 22 | 11 | 37 |
| | 25 | 20 | 8 |
| | 29 | 4 | 39 |

### Y Cygni 202 ‡.

$$\left\{\begin{array}{l} 1=1^{h}\ 4^{m}\ \ 2^{s} \\ 2=2\ \ 23\ \ 55 \\ 3=4\ \ 3\ \ 56 \end{array}\right\}$$

| | d | h | m |
|---|---|---|---|
| Jan. | 1 | 23 | 57 |
| | 7 | 23 | 47 |
| | 13 | 23 | 37 |
| | 19 | 23 | 27 |
| | 25 | 23 | 17 |
| | 31 | 23 | 6 |
| Feb. | 6 | 22 | 56 |
| | 12 | 22 | 46 |
| | 18 | 22 | 36 |
| | 24 | 22 | 26 |

### Y Cygni 202 ‡ (*continued*).

| | d | h | m |
|---|---|---|---|
| March. | 2 | 22 | 16 |
| | 8 | 22 | 5 |
| | 14 | 21 | 55 |
| | 20 | 21 | 45 |
| | 26 | 21 | 35 |
| April. | 1 | 21 | 25 |
| | 7 | 21 | 15 |
| | 13 | 21 | 4 |
| | 19 | 20 | 54 |
| | 25 | 20 | 44 |
| May. | 1 | 20 | 34 |
| | 7 | 20 | 24 |
| | 13 | 20 | 14 |
| | 19 | 20 | 3 |
| | 25 | 19 | 53 |
| | 31 | 19 | 43 |
| June. | 6 | 19 | 33 |
| | 12 | 19 | 23 |
| | 18 | 19 | 13 |
| | 24 | 19 | 3 |
| | 30 | 18 | 52 |
| July. | 6 | 18 | 42 |
| | 12 | 18 | 32 |
| | 18 | 18 | 22 |
| | 24 | 18 | 12 |
| | 30 | 18 | 2 |
| August. | 5 | 17 | 51 |
| | 11 | 17 | 41 |
| | 17 | 17 | 31 |
| | 23 | 17 | 21 |
| | 29 | 17 | 11 |
| Sept. | 4 | 17 | 1 |
| | 10 | 16 | 50 |
| | 16 | 16 | 40 |
| | 22 | 16 | 30 |
| | 28 | 16 | 20 |
| Oct. | 4 | 16 | 10 |
| | 10 | 16 | 0 |
| | 16 | 15 | 49 |
| | 22 | 15 | 39 |
| | 28 | 15 | 29 |
| Nov. | 3 | 15 | 19 |
| | 9 | 15 | 9 |
| | 15 | 14 | 59 |
| | 21 | 14 | 49 |
| | 27 | 14 | 38 |
| Dec. | 3 | 14 | 28 |
| | 9 | 14 | 18 |
| | 15 | 14 | 8 |
| | 21 | 13 | 58 |
| | 27 | 13 | 48 |

### S Antliæ 68 §.

| | d | h | m |
|---|---|---|---|
| Jan. | 1 | 3 | 28 |
| | 4 | 9 | 16 |
| | 7 | 15 | 4 |
| | 10 | 20 | 52 |
| | 14 | 2 | 40 |
| | 17 | 8 | 28 |
| | 20 | 14 | 16 |
| | 23 | 20 | 4 |
| | 27 | 1 | 52 |
| | 30 | 7 | 40 |
| Feb. | 2 | 13 | 28 |
| | 5 | 19 | 16 |
| | 9 | 1 | 4 |
| | 12 | 6 | 52 |
| | 15 | 12 | 40 |
| | 18 | 18 | 28 |
| | 22 | 0 | 16 |
| | 25 | 6 | 4 |
| | 28 | 11 | 52 |

### S Antliæ 68 § (*continued*).

| | d | h | m |
|---|---|---|---|
| March. | 3 | 17 | 40 |
| | 6 | 23 | 28 |
| | 10 | 5 | 16 |
| | 13 | 11 | 4 |
| | 16 | 16 | 52 |
| | 19 | 22 | 40 |
| | 23 | 14 | 28 |
| | 26 | 10 | 16 |
| | 29 | 16 | 4 |
| April. | 1 | 21 | 52 |
| | 5 | 3 | 40 |
| | 8 | 9 | 28 |
| | 11 | 15 | 16 |
| | 14 | 21 | 4 |
| | 18 | 2 | 52 |
| | 21 | 8 | 40 |
| | 24 | 14 | 28 |
| | 27 | 20 | 16 |
| May. | 1 | 2 | 4 |
| | 4 | 7 | 52 |
| | 7 | 13 | 40 |
| | 10 | 19 | 28 |
| | 14 | 1 | 16 |
| | 17 | 7 | 4 |
| | 20 | 12 | 52 |
| | 23 | 18 | 40 |
| | 27 | 0 | 28 |
| | 30 | 6 | 16 |
| June. | 2 | 12 | 4 |
| | 5 | 17 | 52 |
| | 8 | 23 | 40 |
| | 12 | 5 | 28 |
| | 15 | 11 | 16 |
| | 18 | 17 | 4 |
| | 21 | 22 | 52 |
| | 25 | 4 | 40 |
| | 28 | 10 | 28 |
| July. | 1 | 16 | 16 |
| | 4 | 22 | 4 |
| | 8 | 3 | 52 |
| | 11 | 9 | 40 |
| | 14 | 15 | 28 |
| | 17 | 21 | 16 |
| | 21 | 3 | 4 |
| | 24 | 8 | 52 |
| Sept. | 1 | 6 | 28 |
| | 4 | 12 | 16 |
| | 7 | 18 | 4 |
| | 10 | 23 | 52 |
| | 14 | 5 | 40 |
| | 17 | 11 | 28 |
| | 20 | 17 | 16 |
| | 23 | 23 | 4 |
| | 27 | 4 | 52 |
| | 30 | 10 | 40 |
| Oct. | 3 | 16 | 28 |
| | 6 | 22 | 16 |
| | 10 | 4 | 4 |
| | 13 | 9 | 52 |
| | 16 | 15 | 40 |
| | 19 | 21 | 28 |
| | 23 | 3 | 16 |
| | 26 | 9 | 4 |
| | 29 | 14 | 52 |
| Nov. | 1 | 20 | 40 |
| | 5 | 2 | 28 |
| | 8 | 8 | 16 |
| | 11 | 14 | 4 |
| | 14 | 19 | 52 |
| | 18 | 1 | 40 |
| | 21 | 7 | 28 |
| | 24 | 13 | 16 |
| | 27 | 19 | 4 |
| Dec. | 1 | 0 | 52 |
| | 4 | 6 | 40 |
| | 7 | 12 | 28 |
| | 10 | 18 | 16 |
| | 13 | 0 | 4 |
| | 17 | 5 | 52 |
| | 20 | 11 | 40 |
| | 23 | 17 | 28 |
| | 26 | 23 | 16 |
| | 30 | 5 | 4 |

‡ Every fourth minimum only.

§ Every tenth minimum only; the others may be found by adding the multiples of period in the following table :—

| P. | h m | P. | d h m | P. | d h m |
|---|---|---|---|---|---|
| 1 | 7 47 | 4 | 1 7 7 | 7 | 2 6 28 |
| 2 | 15 34 | 5 | 1 14 54 | 8 | 2 14 4 |
| 3 | 23 20 | 6 | 1 22 41 | 9 | 2 22 1 |

## MAXIMA AND MINIMA OF VARIABLE STARS.

The No. refers to Catalogue on pp. 25–26; M signifies maximum; *m*, minimum.

### January.

| d | No. | |
|---|---|---|
| 1 | 3 | *m* |
| | 161 | *m* |
| 2 | 148 | *m* |
| | 33 | *m* |
| 3 | 100 | M |
| 4 | 188 | M |
| | 162 | M |
| 5 | 2 | M |
| 6 | 35 | M |
| 7 | 27 | M |
| 8 | 165 | *m* |
| | 66 | *m* |
| | 29 | M |
| 10 | 200 | *m* |
| | 78 | M |
| | 88 | *m* |
| 11 | 50 | *m* |
| | 74 | *m* |
| 12 | 222 | M |
| | 187 | *m* |
| 13 | 15 | M |
| | 47 | M |
| 15 | 71 | *m* |
| | 51 | M |
| 16 | 19 | *m* |
| 17 | 24 | *m* |
| | 176 | *m* |
| 19 | 116 | M |
| 20 | 180 | *m* |
| | 45 | *m* |
| 21 | 16 | M |
| 22 | 198 | *m* |
| 24 | 131 | M |
| | 196 | M |
| 26 | 22 | M |
| | 74 | M |
| 27 | 157 | *m* |
| 28 | 26 | M |
| 29 | 168 | M |
| | 50 | M |
| 30 | 211 | *m* |
| | 165 | M |
| 31 | 56 | M |

### February.

| d | No. | |
|---|---|---|
| 1 | 221 | *m* |
| 3 | 46 | M |
| 4 | 207 | M |
| 5 | 159 | M |
| 6 | 11 | M |
| 7 | 209 | *m* |
| | 95 | M |
| | 139 | M |
| 9 | 162 | *m* |
| 10 | 147 | *m* |
| | 140 | *m* |
| 11 | 72 | *m* |
| | 122 | M |
| | 107 | *m* |
| 12 | 109 | M |
| | 64 | M |
| *13* | *176* | *M* |
| *14* | *43* | *m* |

February (*con.*).

| d | No. | |
|---|---|---|
| 15 | 102 | M |
| | 74 | *m* |
| 16 | 138 | M |
| 17 | 133 | M |
| 19 | 183 | *m* |
| 21 | 104 | M |
| | 77 | *m* |
| 22 | 92 | *m* |
| | 170 | M |
| 24 | 172 | M |
| | 76 | M |
| | 10 | M |
| 25 | 165 | *m* |
| | 50 | *m* |
| 26 | 131 | *m* |
| | 204 | M |
| 27 | 212 | M |
| | 37 | M |
| | 188 | *m* |
| | 12 | M |
| 28 | 141 | M |

### March.

| d | No. | |
|---|---|---|
| 2 | 74 | M |
| 3 | 198 | M |
| | 219 | *m* |
| | 87 | M |
| | 105 | M |
| | 206 | *m* |
| 4 | 224 | *m* |
| | 182 | M |
| 5 | 136 | M |
| | 174 | *m* |
| 6 | 108 | M |
| 7 | 19 | *m* |
| | 191 | M |
| 8 | 218 | M |
| 9 | 203 | *m* |
| | 185 | M |
| | 175 | *m* |
| 11 | 111 | M |
| | 136 | M |
| 15 | 50 | M |
| | 188 | M |
| 16 | 59 | M |
| | 162 | M |
| 19 | 30 | *m* |
| 20 | 91 | M |
| | 165 | M |
| 21 | 145 | *m* |
| | 89 | *m* |
| 22 | 120 | M |
| | 31 | M |
| | 74 | *m* |
| 26 | 176 | *m* |
| 27 | 207 | *m* |
| | 124 | M |
| 29 | 152 | M |
| | 29 | *m* |
| *30* | *64* | *M* |
| *31* | *47* | *m* |

March (*con.*).

| d | No. | |
|---|---|---|
| 31 | 118 | *m* |
| | 210 | *m* |

### April.

| d | No. | |
|---|---|---|
| 2 | 81 | M |
| 3 | 49 | M |
| | 25 | M |
| 5 | 104 | *m* |
| | 24 | M |
| | 224 | M |
| | 143 | M |
| 6 | 74 | M |
| 8 | 200 | M |
| | 208 | M |
| | 135 | M |
| 9 | 187 | M |
| | 114 | M |
| 10 | 169 | M |
| 11 | 17 | M |
| | 54 | *m* |
| | 73 | M |
| 12 | 50 | *m* |
| | 4 | M |
| 15 | 165 | *m* |
| | 157 | M |
| 18 | 14 | M |
| 20 | 125 | M |
| | 209 | M |
| 21 | 176 | M |
| 22 | 162 | *m* |
| 24 | 11 | *m* |
| 25 | 167 | M |
| 26 | 74 | *m* |
| 27 | 131 | M |
| | 16 | M |
| | 56 | M |
| 28 | 88 | M |
| | 76 | *m* |
| | 16 | *m* |
| | 123 | M |
| 30 | 50 | M |

### May.

| d | No. | |
|---|---|---|
| 6 | 214 | M |
| | 122 | *m* |
| 7 | 165 | M |
| 9 | 188 | *m* |
| | 220 | M |
| 10 | 203 | M |
| | 189 | M |
| 11 | 53 | *m* |
| | 74 | M |
| | 192 | *m* |
| 15 | 85 | M |
| | 134 | M |
| | 115 | M |
| 16 | 205 | *m* |
| 17 | 127 | *m* |
| 18 | 22 | *m* |
| | 223 | M |
| *20* | *161* | *M* |
| *21* | *224* | *M* |

May (*con.*).

| d | No. | |
|---|---|---|
| 21 | 97 | M |
| | 92 | M |
| | 45 | M |
| 22 | 119 | M |
| | 65 | M |
| 23 | 185 | *m* |
| 25 | 188 | M |
| | 10 | *m* |
| | 126 | M |
| 26 | 106 | M |
| | 5 | *m* |
| | 196 | *m* |
| | 26 | *m* |
| | 102 | *m* |
| 27 | 162 | M |
| | 13 | M |
| | 50 | *m* |
| | 213 | M |
| 28 | 100 | M |
| | 89 | M |
| 29 | 131 | *m* |
| | 197 | M |
| 30 | 148 | M |
| | 47 | M |
| 31 | 74 | *m* |

### June.

| d | No. | |
|---|---|---|
| 1 | 222 | *m* |
| | 176 | *m* |
| 2 | 165 | *m* |
| | 147 | M |
| 4 | 9 | *m* |
| 5 | 35 | *m* |
| | 111 | *m* |
| 6 | 101 | M |
| 7 | 36 | M |
| 8 | 24 | *m* |
| | 77 | M |
| 9 | 180 | M |
| | 217 | M |
| 10 | 81 | *m* |
| 11 | 116 | *m* |
| 14 | 50 | M |
| 15 | 109 | *m* |
| | 74 | M |
| 16 | 172 | *m* |
| 17 | 71 | M |
| | 209 | *m* |
| | 175 | M |
| 20 | 98 | M |
| 21 | 88 | M |
| | 137 | M |
| 23 | 104 | M |
| | 170 | *m* |
| 24 | 135 | *m* |
| 25 | 165 | M |
| 26 | 29 | M |
| | 107 | M |
| 28 | 176 | M |
| 29 | 32 | M |
| 30 | 39 | M |
| | 51 | *m* |

### July.

| d | No. | |
|---|---|---|
| 1 | 110 | M |
| 2 | 162 | *m* |
| | 34 | *m* |
| 6 | 74 | *m* |
| | 82 | M |
| | 190 | M |
| 7 | 43 | M |
| | 16 | M |
| | 198 | *m* |
| | 91 | *m* |
| 9 | 195 | M |
| | 118 | M |
| 10 | 157 | *m* |
| 11 | 50 | *m* |
| 12 | 28 | M |
| | 19 | M |
| 13 | 183 | M |
| 15 | 87 | *m* |
| 18 | 188 | *m* |
| 19 | 194 | M |
| | 105 | *m* |
| 20 | 165 | *m* |
| 21 | 74 | M |
| | 14 | *m* |
| 22 | 182 | *m* |
| | 56 | M |
| 23 | 76 | M |
| 24 | 145 | M |
| | 58 | *m* |
| 25 | 203 | *m* |
| | 122 | M |
| | 169 | *m* |
| | 102 | M |
| 26 | 178 | *m* |
| 27 | 140 | M |
| | 132 | M |
| | 177 | M |
| 28 | 131 | M |
| 29 | 50 | M |
| 30 | 221 | M |
| 31 | 72 | M |

### August.

| d | No. | |
|---|---|---|
| 2 | 200 | *m* |
| | 174 | M |
| | 204 | M |
| 3 | 185 | M |
| | 188 | M |
| 4 | 104 | *m* |
| | 26 | M |
| 6 | 162 | M |
| 7 | 121 | M |
| 8 | 176 | *m* |
| | 187 | *m* |
| 9 | 207 | M |
| | 3 | M |
| 10 | 74 | *m* |
| 12 | 165 | M |
| | 108 | *m* |
| 13 | 89 | *m* |
| 14 | 47 | *m* |
| 16 | 38 | *m* |
| | 54 | M |

August (*con.*).

| d | No. | |
|---|---|---|
| 16 | 198 | M |
| | 10 | M |
| 18 | 96 | *m* |
| 19 | 15 | *m* |
| 20 | 172 | M |
| | 114 | *m* |
| 21 | 224 | M |
| 22 | 22 | M |
| | 219 | M |
| 24 | 46 | *m* |
| | 49 | *m* |
| 25 | 74 | M |
| | 24 | M |
| | 50 | *m* |
| 29 | 209 | M |
| 30 | 131 | *m* |
| 31 | 33 | M |

### September.

| d | No. | |
|---|---|---|
| 2 | 59 | *m* |
| | 11 | M |
| | 176 | M |
| 3 | 150 | M |
| | 111 | M |
| 5 | 99 | M |
| 6 | 165 | *m* |
| | 192 | M |
| 8 | 6 | *m* |
| 9 | 8 | *m* |
| | 12 | *m* |
| 10 | 205 | M |
| 11 | 162 | *m* |
| 12 | 50 | M |
| | 206 | M |
| 14 | 74 | *m* |
| | 29 | *m* |
| 15 | 175 | *m* |
| | 84 | M |
| 17 | 92 | *m* |
| 21 | 191 | *m* |
| | 88 | *m* |
| 24 | 76 | *m* |
| | 109 | M |
| 25 | 203 | M |
| 26 | 196 | M |
| | 157 | M |
| | 188 | *m* |
| 27 | 211 | M |
| 28 | 73 | *m* |
| 29 | 74 | M |
| | 165 | M |

### October.

| d | No. | |
|---|---|---|
| 1 | 13 | *m* |
| 5 | 25 | *m* |
| 7 | 214 | M |
| 8 | 87 | M |
| | 18 | M |
| 9 | 118 | *m* |
| | 61 | M |
| | 50 | *m* |

October (*con.*).

| d | No. | |
|---|---|---|
| 11 | 170 | M |
| | 75 | M |
| 12 | 16 | *m* |
| | 188 | M |
| 13 | 2 | M |
| | 81 | M |
| | 47 | M |
| 14 | 147 | *m* |
| | 176 | *m* |
| 15 | 127 | M |
| | 37 | *m* |
| | 95 | M |
| 16 | 162 | M |
| | 122 | *m* |
| | 185 | *m* |
| 17 | 56 | M |
| 18 | 5 | M |
| 19 | 74 | *m* |
| | 30 | M |
| 20 | 167 | *m* |
| | 89 | M |
| 21 | 14 | M |
| 22 | 104 | M |
| | 136 | M |
| 24 | 165 | *m* |
| 26 | 209 | *m* |
| 27 | 64 | M |
| | 50 | M |
| 28 | 24 | *m* |
| | 91 | M |
| 29 | 131 | M |
| | 148 | *m* |
| | 1 | M |
| | 200 | M |
| | 52 | M |
| 31 | 208 | M |

### November.

| d | No. | |
|---|---|---|
| 1 | 31 | *m* |
| 2 | 35 | M |
| | 46 | M |
| 3 | 74 | M |
| | 187 | M |
| | 102 | *m* |
| | 184 | M |
| 5 | 57 | M |
| | 142 | M |
| 8 | 17 | M |
| | 107 | *m* |
| 10 | 176 | M |
| 13 | 79 | |
| 14 | 10 | *m* |
| | 40 | M |
| 16 | 165 | M |
| 17 | 135 | M |
| | 108 | M |
| | 11 | *m* |
| 20 | 123 | M |
| 21 | 162 | *m* |
| 22 | 120 | *m* |
| | 71 | *m* |

November (*con.*).

| d | No. | |
|---|---|---|
| 23 | 74 | *m* |
| 24 | 50 | *m* |
| | 182 | M |
| | 199 | M |
| 25 | 143 | M |
| 26 | 105 | M |
| | 212 | M |
| | 161 | *m* |
| | 58 | M |
| 27 | 126 | *m* |
| 29 | 111 | *m* |
| 30 | 26 | *m* |
| | 134 | M |
| | 131 | *m* |

### December.

| d | No. | |
|---|---|---|
| 3 | 17 | M |
| | 114 | M |
| 4 | 104 | *m* |
| 6 | 188 | *m* |
| | 4 | *m* |
| 7 | 139 | M |
| 8 | 74 | M |
| | 149 | M |
| 9 | 15 | M |
| | 203 | *m* |
| 10 | 172 | *m* |
| | 165 | *m* |
| 11 | 51 | M |
| 12 | 50 | M |
| | 22 | *m* |
| | 29 | M |
| 13 | 59 | M |
| | 218 | M |
| | 210 | M |
| 14 | 92 | M |
| 15 | 137 | M |
| 18 | 197 | M |
| 19 | 76 | M |
| 20 | 205 | *m* |
| | 198 | *m* |
| 21 | 176 | *m* |
| | 207 | *m* |
| | 21 | M |
| | 16 | M |
| | 9 | M |
| 22 | 81 | *m* |
| | 157 | *m* |
| | 188 | M |
| 23 | 77 | *m* |
| 24 | 180 | *m* |
| | 175 | M |
| | 97 | *m* |
| 26 | 162 | M |
| 27 | 185 | M |
| 28 | 74 | *m* |
| | 145 | *m* |
| 29 | 47 | *m* |
| 30 | 171 | M |
| | 169 | M |
| 31 | 100 | M |

## DOUBLE STARS.

| No. | Name of Star. | R.A. 1890. | Dec. 1890. | Mag. | Pos.-angle. | Distance. | Epoch. 1880+. | Observer. |
|---|---|---|---|---|---|---|---|---|
| | | h m | ° ′ | | ° | ″ | | |
| 1. | Σ 3062 | 0 0·8 | +57 51 | 6 ; 7 | 331·9 | 1·36 | 13·04 | G. |
| 2. | OΣ 4 | 0 11·1 | +35 52 | 7 ; 8 | 141·1 | 0·30 | 7·93 | HΣ. |
| 3. | OΣ 12, λ Cassiop. | 0 25·7 | +53 55 | 6½ ; 6½ | 154·9 | 0·30 | 13·03 | G. |
| 4. | OΣ 18 | 0 36·9 | + 3 35 | 8 ; 10 | 124·2 | 1·37 | 6·97 | H. |
| 5. | β 866 | 0 38·9 | +42 33 | 9 ; 9 | 69·6 | 1·39 | 11·83 | β. |
| 6. | Σ 60, η Cassiop. | 0 42·5 | +57 14 | 3½ ; 7½ | 200·2 | 4·96 | 14·13 | M. |
| 7. | OΣ 20, 66 Piscium | 0 45·8 | +18 36 | 6 ; 7 | 328·9 | 0·36 | 14·85 | Ls. |
| 8. | Σ 73, 36 Andromedæ | 0 48·9 | +23 2 | 6 ; 6½ | 12·4 | 1·07 | 14·06 | M. |
| 9. | Σ 113, 42 Ceti | 1 14·0 | − 1 5 | 6½ ; 7 | 352·9 | 1·48 | 13·04 | M. |
| 10. | Σ 138 | 1 30·3 | + 7 5 | 7 ; 7 | 216·8 | 1·22 | 13·86 | Ls. |
| 11. | p Eridani | 1 35·7 | −56 45 | 6 ; 6 | 226·6 | 7·02 | 12·92 | T. |
| 12. | Σ 158 | 1 40·6 | +32 37 | 8 ; 9 | 255·3 | 1·92 | 7·92 | H. |
| 13. | Σ 183, AB | 1 49·0 | +28 15 | 7 ; 8 | 2·5 | 0·51 | 7·96 | H. |
| 14. | Σ 185 | 1 51·2 | +74 55 | 7 ; 8½ | 29·9 | 1·31 | 1·66 | β. |
| 15. | Σ 202, α Piscium | 1 56·0 | + 2 13 | 4 ; 4½ | 322·8 | 3·03 | 12·74 | G. |
| 16. | Σ 205 Andromedæ | 1 57·1 | +41 48 | 4 ; 5 | 320·1 | 2·97 | 7·49 | H. |
| 17. | Σ 208, 10 Arietis | 1 57·4 | +25 24 | 6½ ; 8½ | 46·7 | 1·71 | 10·03 | Kn. |
| 18. | Σ 228 | 2 6·9 | +46 58 | 6½ ; 7½ | 51·3 | 0·33 | 10·04 | H. |
| 19. | Σ 333, ε Arietis | 2 52·9 | +20 54 | 5½ ; 6 | 202·7 | 1·26 | 12·92 | G. |
| 20. | Σ 367 | 3 8·3 | + 0 20 | 7½ ; 7½ | 230·7 | 0·66 | 10·10 | T. |
| 21. | Σ 400 | 3 26·0 | +59 39 | 7 ; 8 | 316·0 | 0·62 | 9·93 | H. |
| 22. | Σ 412, 7 Tauri | 3 27·9 | +24 6 | 6½ ; 7 | 216·4 | 0·30 | 9·64 | β. |
| 23. | Σ 422 | 3 32·1 | + 0 14 | 6 ; 8 | 244·9 | 6·25 | 13·09 | M. |
| 24. | Σ 460 | 3 51·7 | +80 24 | 6 ; 7 | 43·8 | 0·96 | 13·21 | M. |
| 25. | Σ 511 | 4 8·7 | +58 31 | 6½ ; 7½ | 273·3 | 0·39 | 10·94 | H. |
| 26. | OΣ 79, 55 Tauri | 4 13·6 | +16 16 | 6½ ; 8 | 87·9 | 0·38 | 10·67 | β. |
| 27. | Σ 535 | 4 17·2 | +11 7 | 7 ; 8 | 333·6 | 1·37 | 13·99 | Ls. |
| 28. | OΣ 98, ι Orionis | 5 1·9 | + 8 21 | 5½ ; 7 | 188·6 | 1·00 | 13·19 | Ls. |
| 29. | Σ 728 | 5 24·9 | + 5 52 | 6 ; 8 | 179·2 | 0·38 | 9·03 | β. |
| 30. | Σ 742, 380 Tauri | 5 30·6 | +21 54 | 7 ; 8 | 258·7 | 3·43 | 13·11 | Ls. |
| 31. | Σ 749 | 5 30·3 | +26 51 | 6½ ; 7 | 167·4 | 1·20 | 13·15 | Ls. |
| 32. | Σ 945 | 6 28·6 | +41 2 | 7 ; 8 | 269·0 | 0·54 | 13·24 | Ls. |
| 33. | Σ 948, 12 Lyncis AB | 6 36·5 | +59 33 | 6 ; 6½ | 121·9 | 1·48 | 13·21 | M. |
| 34. | Σ 982, 38 Geminor. | 6 47·9 | +13 19 | 6 ; 8 | 160·7 | 6·77 | 13·22 | Ls. |
| 35. | OΣ 159, 15 Lyncis | 6 47·8 | +58 34 | 5 ; 6 | 7·5 | 0·81 | 11·09 | H. |
| 36. | Σ 1037 | 7 5·9 | +27 25 | 7 ; 7 | 306·9 | 1·07 | 13·24 | M. |
| 37. | OΣ 170 | 7 12·1 | + 9 30 | 7 ; 7½ | 112·4 | 0·74 | 13·15 | Ls. |
| 38. | Σ 1066, δ Geminor. | 7 13·5 | +22 11 | 3 ; 8 | 206·8 | 7·37 | 13·21 | Ls. |
| 39. | Σ 1074 | 7 14·8 | + 0 36 | 7½ ; 8½ | 144·4 | 0·75 | 13·22 | Ls. |
| 40. | Σ 1093 | 7 21·9 | +50 12 | 8 ; 8½ | 135·6 | 0·72 | 11·20 | H. |
| 41. | Σ 1110, Castor AB | 7 27·6 | +32 8 | 2 ; 3 | 229·6 | 5·67 | 13·19 | Ls. |
| 42. | OΣ 182 | 7 47·2 | + 3 40 | 8½ ; 8½ | 31·9 | 1·26 | 13·19 | Ls. |
| 43. | Σ 1157 | 7 49·0 | − 2 31 | 8 ; 8 | 246·2 | 1·16 | 12·25 | M. |
| 44. | Σ 1187 | 8 2·6 | +32 33 | 7 ; 8 | 45·8 | 2·17 | 13·15 | Ls. |
| 45. | Σ 1196, ζ Cancri AB | 8 5·9 | +18 0 | 5 ; 6 | 20·5 | 1·05 | 14·25 | M. |
| 46. | „ „ AC | …… | …… | …… | 116·0 | 4·98 | 13·21 | M. |
| 47. | „ „ BC | …… | …… | …… | 131·3 | 5·17 | 13·21 | Ls. |
| 48. | β 205 | 8 28·0 | −24 14 | 7 ; 7 | 256·2 | 0·65 | 11·87 | β. |
| 49. | Σ 1273, ε Hydræ | 8 41·0 | + 6 49 | 4 ; 7 | 224·7 | 3·28 | 13·24 | Ls. |
| 50. | Σ 1306, σ² Ursæ Maj. | 9 0·7 | +67 35 | 5 ; 8½ | 224·4 | 1·95 | 9·27 | H. |
| 51. | Σ 3121 | 9 11·3 | +29 3 | 7½ ; 7½ | 177·3 | 0·32 | 13·27 | Ls. |
| 52. | Σ 1338 | 9 13·8 | +38 39 | 7 ; 7½ | 165·7 | 1·52 | 13·28 | Ls. |
| 53. | OΣ 201 | 9 17·3 | +28 24 | 7 ; 11 | 225·3 | 1·31 | 12·32 | M. |
| 54. | Σ 1348 | 9 18·5 | + 6 47 | 7 ; 8 | 324·5 | 1·40 | 13·26 | Ls. |
| 55. | Σ 1356, ω Leonis | 9 22·6 | + 9 31 | 5½ ; 7 | 108·4 | 0·99 | 13·19 | G. |
| 56. | Σ 1417 | 10 9·0 | +19 42 | 8½ ; 8½ | 257·7 | 2·56 | 12·29 | M. |
| 57. | OΣ 215, Piazzi x. 23 | 10 10·3 | +18 17 | 6½ ; 7 | 209·5 | 0·95 | 13·27 | Ls. |
| 58. | Σ 1424, γ Leonis AB | 10 13·9 | +20 24 | 2 ; 4 | 115·0 | 3·73 | 13·30 | Ls. |
| 59. | Σ 1457 | 10 32·0 | + 6 20 | 7½ ; 8 | 316·3 | 0·96 | 13·34 | Ls. |
| 60. | OΣ 224 | 10 34·1 | + 9 26 | 7 ; 9 | 306·0 | 0·61 | 13·31 | Ls. |

## DOUBLE STARS (*continued*).

| No. | Name of Star. | R.A. 1890. | Dec. 1890. | Mag. | Pos.-angle. | Distance. | Epoch 1880+. |
|---|---|---|---|---|---|---|---|
| | | h m | ° ′ | | ° | ″ | ʹ |
| 61. | OΣ 229 ................. | 10 43·3 | +41 42 | 6 ; 7 | 322·9 | 0·83 | 12·44 |
| 62. | Σ 1523, ξ Ursæ Maj. . | 11 12·3 | +32 9 | 4 ; 5 | 183·0 | 1·87 | 14·35 |
| 63. | Σ 1536, ι Leonis ...... | 11 18·2 | +11 8 | 4½ ; 7½ | 59·6 | 2·55 | 13·38 |
| 64. | OΣ 235 ................. | 11 26·1 | +61 42 | 5½ ; 7 | 84·3 | 0·97 | 12·12 |
| 65. | Σ 1606 ................. | 12 5·3 | +40 31 | 6 ; 7 | 335·7 | 1·07 | 13·36 |
| 66. | Σ 1647, 191 Virginis... | 12 25·0 | +10 10 | 7½ ; 8 | 219·6 | 1·32 | 13·36 |
| 67. | Σ 1670, γ Virginis ... | 12 36·1 | − 0 51 | 3 ; 3 | 151·7 | 5·86 | 13·32 |
| 68. | Σ 1687, 35 Comæ...... | 12 47·9 | +21 52 | 5 ; 8 | 73·1 | 1·49 | 13·37 |
| 69. | Σ 1728, 42 Comæ...... | 13 4·7 | +18 7 | 5½ ; 6 | 19·5 | 0·47 | 13·41 |
| 70. | OΣ 266 ................. | 13 23·1 | +16 18 | 7 ; 8 | 339·9 | 1·72 | 12·50 |
| 71. | Σ 1757, Piazzi xiii. 127 | 13 28·9 | + 0 15 | 7½ ; 8 | 80·0 | 2·62 | 13·42 |
| 72. | Σ 1768, 25 Can. Ven. . | 13 33·0 | +36 46 | 6 ; 8 | 137·5 | 0·98 | 12·17 |
| 73. | Σ 1785 ................. | 13 44·2 | +27 27 | 7½ ; 8 | 249·1 | 1·71 | 12·48 |
| 74. | Σ 1788 ................. | 13 49·0 | − 7 31 | 6½ ; 7½ | 76·1 | 2·60 | 11·12 |
| 75. | Σ 1819 ................. | 14 9·8 | + 3 39 | 7½ ; 7½ | 185·4 | 1·38 | 14·42 |
| 76. | Σ 1865, ζ Boötis ...... | 14 36·0 | +14 12 | 4 ; 4 | 285·4 | 0·52 | 13·49 |
| 77. | Σ 1876 ................. | 14 40·8 | − 6 55 | 8 ; 8 | 251·5 | 1·30 | 8·31 |
| 78. | Σ 1888, ξ Boötis ...... | 14 46·3 | +19 33 | 5 ; 7 | 231·2 | 2·90 | 14·53 |
| 79. | OΣ 287 ................. | 14 47·6 | +45 22 | 7 ; 8 | 321·9 | 0·94 | 13·49 |
| 80. | β 239 ................... | 14 52·0 | −27 12 | 6 ; 6 | 311·4 | 0·86 | 9·44 |
| 81. | β 119 ................... | 14 59·7 | − 6 35 | 8 ; 8½ | 306·4 | 1·61 | 8·45 |
| 82. | Σ 1932, 1 Cor. Bor.... | 15 13·5 | +27 15 | 6½ ; 7 | 317·3 | 0·94 | 13·50 |
| 83. | Σ 1937, η Cor. Bor.... | 15 18·6 | +30 41 | 6 ; 6 | 245·3 | 0·85 | 13·50 |
| 84. | Σ 1938, $\mu^2$ Boötis...... | 15 20·3 | +37 46 | 6½ ; 7½ | 88·6 | 0·77 | 13·49 |
| 85. | OΣ 298 ................. | 15 32·5 | +40 13 | 7 ; 7½ | 170·6 | 1·03 | 13·46 |
| 86. | Σ 1967, γ Cor. Bor.... | 15 35·0 | +37 0 | 4 ; 7 | 123·5 | 0·53 | 14·50 |
| 87. | OΣ 303 ................. | 15 56·0 | +13 35 | 7 ; 7½ | 139·9 | 0·97 | 11·52 |
| 88. | Σ 1998, ξ Scorpii ...... | 15 57·7 | −11 4 | 5 ; 5½ | 208·0 | 1·23 | 12·53 |
| 89. | Σ 2032, σ Coronæ...... | 16 11·0 | +34 12 | 6 ; 6½ | 209·8 | 4·24 | 13·62 |
| 90. | Σ 2055, λ Ophiuchi ... | 16 25·0 | + 2 13 | 4½ ; 5½ | 44·9 | 1·21 | 14·51 |
| 91. | Σ 2084, ζ Herculis ... | 16 37·2 | +31 48 | 3 ; 6½ | 40·4 | 1·28 | 14·54 |
| 92. | Σ 2107, 167 Herculis . | 16 47·6 | +28 52 | 7 ; 8½ | 254·1 | 0·38 | 8·60 |
| 93. | Σ 2173, 221 Ophiuchi. | 17 24·5 | − 0 58 | 6 ; 6 | 336·8 | 1·14 | 14·54 |
| 94. | OΣ 338 ................. | 17 47·0 | +15 21 | 6½ ; 6½ | 21·2 | 0·84 | 9·73 |
| 95. | Σ 2262, τ Ophiuchi ... | 17 57·1 | − 8 11 | 5 ; 6 | 253·9 | 1·84 | 13·47 |
| 96. | Σ 2272, 70 Ophiuchi . | 18 0·0 | + 2 33 | 4 ; 6 | 307·4 | 2·29 | 14·54 |
| 97. | OΣ 358 ................. | 18 31·0 | +16 50 | 6½ ; 7 | 198·4 | 1·73 | 8·74 |
| 98. | Σ 2382, $\epsilon_1$ Lyræ ...... | 18 40·8 | +39 34 | 5 ; 5½ | 12·2 | 3·12 | 12·71 |
| 99. | Σ 2383, $\epsilon_2$ Lyræ (5)... | 18 40·8 | +39 29 | 5 ; 5½ | 131·7 | 2·36 | 12·71 |
| 100. | γ Coronæ Australis ... | 18 59·0 | −37 14 | 5½ ; 5½ | 172·5 | 1·61 | 12·76 |
| 101. | β 248 ................... | 19 12·9 | +22 51 | 6 ; 9 | 125·4 | 1·86 | 10·63 |
| 102. | Schjellerup 30 ......... | 19 21·5 | −12 22 | 8 ; 8 | 328·3 | 1·60 | 8·54 |
| 103. | Σ 2579, δ Cygni ...... | 19 41·5 | +44 50 | 3 ; 8 | 316·1 | 1·62 | 10·56 |
| 104. | OΣ 387 ................. | 19 44·5 | +35 2 | 7 ; 8 | 354·6 | 0·55 | 8·76 |
| 105. | β 151, β Delphini ... | 20 32·4 | +14 13 | 3½ ; 5½ | 338·7 | 0·50 | 12·39 |
| 106. | OΣ 413, λ Cygni ...... | 20 43·1 | +36 8 | 5 ; 7½ | 70·5 | 0·66 | 9·86 |
| 107. | Σ 2729 ................. | 20 46·0 | − 6 2 | 6½ ; 6½ | 184·5 | 9·55 | 12·70 |
| 108. | Σ 2799 ................. | 21 23·3 | +10 36 | 7 ; 7½ | 298·2 | 1·74 | 12·66 |
| 109. | β 170 ................... | 22 3·0 | −19 1 | 8 ; 8 | 60·4 | 1·56 | 8·78 |
| 110. | Σ 2909, ζ Aquarii...... | 22 23·2 | − 0 36 | 4 ; 4 | 323·0 | 3·18 | 14·78 |
| 111. | Σ 2944, AB ............ | 22 42·1 | − 4 48 | 7 ; 7½ | 255·5 | 3·50 | 12·76 |
| 112. | OΣ 483, 52 Pegasi...... | 22 53·0 | +11 7 | 6 ; 7½ | 216·9 | 1·10 | 11·29 |
| 113. | β 79 ..................... | 23 11·4 | − 2 10 | 8 ; 8½ | 94·6 | 0·88 | 11·54 |
| 114. | β 80 ..................... | 23 12·7 | + 4 45 | 8 ; 8½ | 325·1 | 0·64 | 14·85 |
| 115. | OΣ 547 ................. | 23 59·5 | +45 11 | 8 ; 8 | 340·8 | 4·30 | 11·73 |

In the column headed "Observer," the following abbreviations are used:—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *L.* | *Leavenworth.* | G. | Glasenapp. | H. | Hall. | T. | Tebbu |
| *S.* | *Seabroke.* | β. | Burnham. | Kn. | Knorre. | Ls. | Lewis |
| *HΣ.* | *Herman Struve.* | M. | Maw. | Pk. | Pollock. | | |

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

No. 223. JANUARY. 1895.

## MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, December 14, 1894.

Capt. W. DE W. ABNEY, C.B., F.R.S., *President*, in the Chair.

*Secretaries*: Prof. H. H. TURNER, M.A., B.Sc., and
E. W. MAUNDER.

THE Minutes of the previous Meeting were read and confirmed.

*Mr. Maunder.* 105 presents have been received since the date of the last meeting. Of these special attention may be called to a volume by Dr. A. Donner on the Determination of the Constants necessary for the reduction of plates taken at Helsingfors for the construction of the Photographic Chart of the Heavens, and to the volume from the Lund Observatory, containing the observations of stars in the zone +35° to +40° dec. for the Astronomische Gesellschaft Catalogue. Then we have a large number of memoirs and photographs by M. Deslandres on the subject of the work by which he is so distinguished. We have also received the fourth volume of publications of the Vatican Observatory, Rome, in which there are some beautiful reproductions of astronomical photographs. Prof. Frost has presented a copy of his work, the translation and revision of Dr. Scheiner's 'Astronomical Spectroscopy.' The book is somewhat more than a translation, for it has been revised and enlarged, and is almost a new work; and, lastly, Mr. Howlett has presented to the Society three splendid volumes of his beautiful drawings of sun-spots.

Mr. J. E. Drower, Mr. W. B. Gibbs, and Mr. H. P. Hollis were appointed Auditors of the Treasurer's accounts for 1894.

*Prof. Turner.* There are several papers on observations of the Transit of Mercury on Nov. 10 last. Lieut. Basil Taylor, whose name is proposed for election to the Society this evening, observed the transit from H.M.S. 'Blake' on the North American Station, but was unable to note the time of external contact. The Rev. Samuel Charlesworth, who took considerable interest in making arrangements for those who wanted to see the transit under more favourable conditions than were obtainable in the British Islands, and who, in fact, secured from some of the steamship companies the possibility of going over to the States at rather reduced fares, went to the States himself, although a very old man, and was fortunate enough to see the transit in Washington, partly on the Capitol itself and partly at the Washington Observatory. He sends us a letter describing his experiences, which I am afraid is rather too long to read; but he was favoured with excellent weather and did see the transit after his journey across the Atlantic for the special purpose. He encloses some newspaper extracts, the value of which I am not concerned perhaps to assess, which state that a newspaper reporter who saw the transit believed he also saw a gaseous body attending Mercury; this appearance, however, is not confirmed by anyone else. Mr. Eddie saw the transit of Mercury at Grahamstown, Cape of Good Hope, and gives the time of the transit and several notes of phenomena which confirm notes by other observers. Mr. Lindemann communicates some notes of an expedition, in which I was myself his companion, and I can say we made a most successful observation from the top of a hill near his observatory at Sidmouth, Devonshire. We saw ingress in an interval of clear sky between two showers, and the times of contact agree with those of observations contributed by the Rev. S. J. Johnson, who is well known as one who takes an interest in such phenomena. Mr. Johnson found that the planet entered on the disc of the Sun about 45 seconds later than the time mentioned in the 'Nautical Almanac.' Capt. Noble has given us the times noted by Prof. Barnard, who observed both ingress and egress very successfully. The conditions were splendid. No halo was detected round the planet when on the Sun's disc nor were there any spots on Mercury, and the time of contact is given as $5^h\ 7^m\ 54^s$. It was not visible to the naked eye, but it was seen with a small pocket telescope with a magnifying-power of 2½. The absence of the phenomena just mentioned was also a point noted by Mr. Lindemann and myself, and I suppose, as he does not mention it, the same remark holds in the case of Mr. Johnson.

*Mr. Howlett.* I have the honour to request the Society to accept an instalment, and I think the final one, of my drawings of solar spots. In these three volumes many thousands of spots, great and small, are delineated. The series extends over a period of 35 years of more or less continuous observation, from 1859 to 1893. The work has been one of the deepest interest to me, but since photography has come in I have sometimes doubted whether it is worth while to continue to make drawings of spots, which accounts for breaks in the work. The main object I have had in view in maintaining this series of drawings has been to test the theory first put forward by Prof. Wilson of Glasgow in the 'Philosophical Transactions,' 1774—to examine the assertion that as a spot approaches the edge of the disc by reason of the Sun's rotation, the apparent breadth of the part of the penumbra on the side nearer the centre of the disc diminishes and finally disappears, because the spots are cavities in the solar surface. Prof. Wilson's observations were made with very imperfect means and appliances, and my opinion is that his case is not made out. There are many spots recorded in the volumes which I now offer to the Society, which distinctly negative this theory; and I can assure my hearers that if they will only adopt the same method of observation (I would recommend the use of a screen by which solar phenomena can be observed with the same ease and comfort as in the reading of a book), they will have no doubt about the point at issue between myself and Prof. Wilson. It is only necessary to use a pair of compasses to measure the width of the penumbra to the right and left of the spots when they are in the closest proximity to the limb. Until this point is definitely settled I do not think it possible to arrive at any true conclusion as to the constitution of the Sun and the dynamical forces at work therein.

*Rev. W. Sidgreaves.* I feel that I ought to say something on this subject, if only on account of the very kind mention in the paper of the late Father Perry. All I can say is that, without any very special attention having been directed to the point at issue, an impression has always been produced upon me (and I can speak for the observer who sketched the spots during Father Perry's time) that is quite in accord with the view now propounded, namely, that there is no unequal contraction of the penumbra whatever, due to perspective.

*Rev. A. L. Cortie.* With regard to the appearance of a spot as a notch in the limb, which has been mentioned as bearing on the question, I remember one drawing made at Stonyhurst which showed such a notch, and this was corroborated at Greenwich, but I forget the date of this. It seems to me, with regard to this discussion whether they are depressions or surface-markings, we ought to observe the spots when they are at their middle life. We cannot decide merely from observations when they are at the beginning or at the end of their appearance. These volumes frequently show the history of a spot right across the disc, as it moves from the following to the preceding side, and such history of a spot is of very great importance.

*Capt. Noble.* At one period of my astronomical life, at the instigation of Mr. Carrington, I devoted a good deal of attention to the Sun, and used to draw spots, and those near the limb seemed, in a considerable number of cases, to favour Prof. Wilson's theory, although there were some which contradicted it, as do those of Mr. Howlett; but I must admit I never took the precaution to notice the exact position of the umbra when they were at the centre of the disc. Of course if the umbra is central it would naturally present a different appearance as it approached the limb to what it would if it were nearer to one side than the other. I am bound to say that the preponderance of appearances was in favour of the Wilson theory in cases where the spots were on the limb.

*Mr. Chambers.* I should like to ask Mr. Howlett a question. Does he deny that a spot with a central umbra becomes unequally foreshortened as to the penumbra as it approaches the edge; or, admitting it as a fact, what explanation can he give of the fact otherwise than the Wilson theory?

*Rev. F. Howlett.* I maintain that I never see any difference in the respective widths of the penumbra east and west of the nucleus.

*Mr. Chambers.* You deny the foreshortening?

*Rev. F. Howlett.* The unequal foreshortening of the inner side.

*Mr. Chambers.* That is a question of fact in which I for one am disposed to join issue.

*Rev. F. Howlett.* But have you actually observed it? Can you produce micrometrical measurements such as these volumes record? I record how near they are to the limb, what is the width of the penumbra, of the umbra, and of both sides of the umbra; it is all closely observed and micrometrically measured. And we want micrometrical measures to settle this point, for it is extraordinary how this idea has been handed on from one astronomer to another, not from one observer to another, until the theory has obtained a firm hold, but resting all the while on a very insecure basis, and we must always remember that error dies hard.

*Father Sidgreaves.* The very great importance of knowing the exact state of the spot before it begins to be foreshortened ought to be emphasized. There may seem to be strong evidence in favour of Wilson's theory, but all may be overthrown by not knowing that the nucleus was not central when the spot was at the centre of the Sun. We have seen on our drawings beautifully shaped spots close to the limb, with the nucleus right in the centre of the penumbra. But it is no use deducing anything from such spots unless you have seen them also at the centre of the disc.

*Capt. Noble.* As a very old magistrate, though not an old man, I may say that this illustrates the maxim that one story is good enough until the other story is told.

*The President.* There will have to be a good deal of consideration before this is accepted. With regard to the theory of uprush and downrush of matter, sometimes put forward to account for the formation of spots, I do not think that there is good evidence. Spectroscopic evidence is the worst, in many ways, you can bring to bear upom matters which require exactitude. Of course, if a current of electricity is able to travel at enormous velocity you will have the same effect as if it was downrush of matter. Therefore, if you see a shifting of spectrum lines, it cannot be definitely ascribed to the shifting of the matter itself. It may be due just as much to the velocity of light itself as to the velocity of the matter itself. We have to thank Mr. Howlett for his noble gift, and I am sure it will be scanned and utilized, and that these matters will be more discussed in future. I also ask you to thank Mr. Howlett for having told us his theory of sun-spots.

*Col. Burton-Brown* then gave a description of a journey he had made to Norway during the past summer, in order to select suitable stations for the observation of the total solar eclipse of August 1896. Col. Brown explained in considerable detail the journey he made and the places he visited. For those who merely wished to watch the eclipse as a spectacle, he said the best course would be for them to go to Trondhjem, and thence to Bodö on the west coast of Norway, or to one of the islands in the immediate neighbourhood. For those who wish to make astronomical observations, the best station would be Vardö, on the east coast, near the mouth of the Varanger Fjord, where fair accommodation could be obtained, and where there was a telegraph station.

*The President.* We have the honour of having with us this evening M. Deslandres, of the Paris Observatory, and I am sure all the Fellows will be pleased to hear what he has to tell us.

*M. Deslandres.* I will show to the Society several photographs taken at the Paris Observatory with two special registering spectrographs, which show separately the shapes and the motions of the vapours of the Sun, and particularly of calcium vapour, as distributed over the whole surface of the disc. In fact, I found, at the same time as Professor Hale of Chicago, that the calcium vapours observed hitherto at the outer part of the limb and above the spots were easily revealed by photography over the whole disc, and chiefly over the faculæ; for the dark lines H and K, in the violet end of the spectrum, which are by far the broadest of the known spectrum lines, have besides, compared with all the other lines, the special property of showing in their centre bright lines which are even doubly reversed. I at once pointed out the necessity of having two distinct registering spectrographs:—1st. A spectrograph for the bright light shapes, made on the following principle: to insulate the bright solar light by a second narrow slit, then to set the solar image in a continuous motion, absolute or relative, before the slit of the collimator, and the plate in a proportional motion before the second slit. This principle had been enunciated previously, for photographing prominences, and even applied in Germany, but unsuccessfully, owing to the feeble sensibility of the plates to the red ray. 2nd. A spectrograph for the determination of motion in the line of sight or the comparison of successive sections of the Sun; the second slit is wide so that it may hold, besides the bright line, a part of the continuous spectrum; moreover the motion is discontinuous, and successive stops and displacements are contrived, so as to cause the juxtaposition of spectra of successive sections.

The first pictures of the shapes taken in this way have been shown to you by Professor Hale, who constructed the corresponding apparatus before I did. However, the photographs I am now showing, in my turn, have a new interest; for the apparatus I used answers the conditions which are necessary if we are to have neat, exact, and complete images, and which up to now had been neglected. In order to get with the spectrograph an image as neat as the solar image projected on the slit of the collimator, it is necessary to have the second slit as wide as the first (or more exactly in the ratio of the focal lengths of the spectrograph and the collimator). Moreover, the second slit must hold the whole line of the flame and no other light. Now this light studied with the ordinary spectrograph widens as the dispersion increases. Therefore it is necessary to have, with a very narrow slit, a dispersion as feeble as possible. Mr. Hale, however, uses the greatest dispersion of his great spectrograph, that is to say, the spectrum of the fourth order, which gives the bright line wide, and even double, with a small, neat, central black line. Under those conditions, either the whole line is insulated by the second slit, necessarily wide, and the neatness is imperilled, or a part only of the line is insulated, and then the vapours are no longer given with their exact intensities; they may completely escape registration when there is in the centre of the bright line the black line, which is longer over the small faculæ and near the limb. This is why the fainter vapours, and especially the vapours near the limb and the poles, are not well shown on Prof. Hale's photograph. Besides, with the prominences the lines are thin, even with this powerful apparatus; but when the prominences are in rapid motion the lines are strongly displaced and go out of the slit; a small dispersion is therefore, from all points of view, necessary. Finally, the two slits must be fixed to the spectroscope, and not movable, as in Mr. Hale's apparatus, in order to avoid the supplementary widening of the second slit, which is the consequence of it.

The spectrograph adopted is composed of a fifty centimetre collimator, one single prism of 60° in light flint, and a three-foot telescope: it moves wholly before a fixed image of the Sun supplied by a Foucault siderostat and a five-inch objective. It is moved by a clepsydra, which communicates a proportional motion to the plate by a simple system of levers. The great length of the telescope ensures the widening of the image without loss of light and renders easier the adjustment of the second slit.

With this small dispersion, which is an essential condition, the vapours appear equally well over the whole disc, the feeblest as well as the strongest, and in the same way also the strong and medium protuberances.

The spectrographs for the successive sections show the speeds of the vapours by the displacements of the lines; on the contrary, a great dispersion is then necessary. I use the fourth spectrum of a Rowland's grating, with $1^{m}\cdot30$ focal length lenses. The bright lines appear nearly double, and the small central black line gives indications on the upper parts of the vapours which with the spectrograph for the shapes cannot be distinguished from the upper parts. Moreover by the variations of brightness of the continuous spectrum they indicate the spots and faculæ, and their connection with the vapours. In fine they give the exact limb of the Sun marked by the sudden stop of the continuous spectrum, and consequently the thickness of the chromosphere, which are not revealed by the spectrographs for the forms.

Such are the two principal apparatus, which must work in a continuous way, like the apparatus of terrestrial meteorology. The spectrographs for the speeds, with their very wide second slit, depend less on the variations of temperature than the spectrographs for the shapes, and adapt themselves better to a continuous registering.

The study of these vapours then is complete. But what is their exact situation in the Sun? On this latter point Mr. Hale and I have from the beginning formed very different opinions. According to Mr. Hale the images of the vapours are identical with the images of the faculæ given by the ordinary telescope without the spectroscope; the vapours are in the photosphere and the faculæ, and he proposes even to estimate the heights of the faculæ by the brightness of the vapours. According to me the images of the vapours and faculæ are not identical, but present only a general concordance of shapes. The vapours are not in the photosphere, but above the chromosphere, and their image is that of the whole chromosphere interior and exterior to the disc, such as it would be seen if the photosphere was taken off. In support of my theory I give decisive proofs.

To compare the two images Mr. Hale gets them with two different apparatus—his spectrograph for the shapes and an ordinary photographic telescope, and the comparison of the two images shows at first sight a striking similitute. As for me, I use only one apparatus, which is an ordinary simple spectroscope or a spectrograph by sections, which give all the elements of the comparison in a manner much more precise and sure though longer. Indeed the apparatus gives on the same plate, with the same exposure and in juxtaposition, the line of the vapour and the strengthening of the continuous spectrum that reveals the faculæ. Now the strengthening of the line which characterizes the vapour has generally a greater length than the strengthening of the light given by the faculæ; sometimes also a vapour is observed without corresponding faculæ, and conversely. Then the two images are not identical. Moreover, the spectrographs by sections show in the line small displacements that do not exist in the neighbouring black lines, so that there is not perfect concordance in the motions between the vapours and the faculæ.

Besides, when one uses with sufficient precautions the ordinary spectroscope or the spectrographs by sections, the double bright line does not only appear on large regions, as Mr. Hale admits, but also on the whole disc. Father Sidgreaves has already called the attention to this point in 1892. These same spectrographs, that each give the edge of the photosphere, enable us to compare the flames exterior and interior to the limb. When a facula is on the limb the chromosphere is shown brighter and higher by the calcium line as well as by the hydrogen line; this part of the chromosphere carried upon the disc by rotation will show a region above the faculæ brighter than the neighbouring part. Besides, along the whole of the limb the bright double line of the interior is prolonged to the exterior by a line also double, which has an equal or greater intensity. These vapours, therefore, must not be considered to be in the photosphere, but they represent the chromosphere, which may now be studied not only in the annulus exterior to the disc, but over the whole sphere turned towards the Earth. Beyond the limb the characteristic features are the elevated parts; on the disc they are the brightest parts. Such are the first results of the studies made with the two spectrographs.

Moreover, the spectrographs for the shapes have enabled us to insulate also some black lines of the spectrum, and to get the image of the vapours producing black lines and so of the reversing layer. The spectrographs for velocities have also given curious results on the general motions of the vapour in the chromosphere; but this latter point will be treated of on some future occasion.

*Mr. Maunder.* I was wondering a few days ago—perhaps it is rather a fanciful idea—in what state our knowledge of solar physics would be if it had not chanced that the apparent diameter of the Moon was just sufficient to occult that of the Sun, and I thought that we should only be just now beginning to learn about the solar chromosphere and the prominences, and that we should be owing to Prof. Hale and M. Deslandres our knowledge of the envelopes of the Sun. I think that idea will give some criterion of the immense value of the work that Prof. Hale and M. Deslandres are carrying on. Yet even that would not be an adequate idea, because the spectrograph which they have invented goes further than to show us simply the hydrogen lines of the solar chromosphere. The spectrograph with two slits enables M. Deslandres not only to photograph the calcium envelope of the Sun, but to select which envelope he will. By choosing, as in these photographs which M. Deslandres has shown, the bright calcium lines we get practically a photograph of the chromosphere or lower part of the chromosphere. By choosing one of the relatively dark lines of the Sun we get really a photograph of a portion of the reversing layer. One of these photographs of the solar surface just shown was taken by M. Deslandres on April 10th of the present year, and we have a photograph taken at Greenwich on the same date. You will see a few spots in the middle of the bright markings, where the Greenwich photograph shows a fine train of spots 100,000 miles long, so that this bright calcium cloud was transparent both to the eye and to the ordinary photographic plate. That fully bears out what M. Deslandres tells us, that these faculous-looking markings on his pictures are not the true faculæ we see upon ordinary occasions. On the Greenwich photograph we can see the spots, but on M. Deslandres' photograph we see the cloud of calcium vapour above them. Then we have another group of spots which are also seen on the Greenwich photograph, but they are very much smaller on this photograph than on the Greenwich picture; that is to say, these calcium vapours have hidden the greater part of it on M. Deslandres' photograph. In *these* places [reference to photograph] the calcium vapour covers a very much larger area than is shown by the faculæ on the ordinary disc. On the other hand, near the opposite limb we have a bright calcium cloud, which corresponds very exactly, both in shape and size, to a group of faculæ on the Greenwich photograph.

*Father Sidgreaves.* First of all it seems to me that these photographs which M. Deslandres has shown us are very remarkable indeed for their excellent definition, especially of that of the prominences. The details of those prominences are shown with a distinctness which is exceedingly surprising. The remarks we have just heard make the whole subject exceedingly interesting, and it is rather a comfort to me because it shows it is worth while continuing, not only the work of solar photography which is done at Greenwich, but also our hand-drawing of the faculæ. There may be a difference between the photographs and the drawings.

*The President.* As there are no other Fellows desiring to make any remarks, I have to ask you to pass a vote of thanks to M. Deslandres for the interesting explanation he has given us of his admirable method for photographing the chromosphere. I think the most remarkable thing is the erratic movement of the prominences, moving at the rate of 100,000 miles a minute. Whatever may be the cause of this, I think that we need not come to the definite conclusion that this is absolutely matter which is moving all this surprising velocity, but that the appearance may proceed from other causes. It is exceedingly interesting from that point of view. We have learned our lesson from text-books where we are told that such and such is the case regarding the prominences and the Sun's surface. It remains to be shown whether the text-books are right or whether new text-books must be written for the rising generation.

The following papers were announced and partly read:—

*C. Michie Smith.* "The Annular Eclipse of the Sun, 1894, April 6."

*C. Michie Smith.* "The Solar Eclipse of 1894, Sept. 29."

*Capt. H. G. Thomas.* "Total Eclipse of the Sun on 1894, Sept. 29."

*J. Tebbutt.* "Result of Micrometer-comparisons of Uranus and α Libræ, 1894, October 5."

*J. Tebbutt.* "Observation of a Daylight Occultation of Antares 1894, October 31."

*W. T. Lynn.* "On the Proper Motions of Three Stars in the Constellation Ophiuchus."

*A. F. Lindemann.* "Observations of the Transit of Mercury on 1894, Nov. 10."

*Rev. S. J. Johnson.* Ditto.

*Lieut. Basil Taylor.* Ditto.

*L. A. Eddie.* Ditto.

*Col. A. Burton-Brown.* "Notes on Suitable Stations in Norway for viewing the Total Solar Eclipse of 1896, August 8."

*H. P. Hollis.* "A Comparison of some Places of Stars observed at the Sydney Observatory with the places of the same Stars as given in the Cape Catalogue, 1880."

*E. J. Stone.* "A Re-determination of the Epoch Correction and Mean Motions for Hansen's Lunar Tables from Meridian Observations of the Moon, 1750–1892."

*E. J. Stone.* "Note on Professor Newcomb's Note in the 'Monthly Notices' for November 1894."

*W. H. M. Christie and F. W. Dyson.* "Account of the Measurement and Comparison of Four Astrographic Plates made at the Royal Observatory, Greenwich."

*Rev. F. Howlett.* "Remarks on Three Volumes of Sun-spot Drawings presented to the Society."

*Dr. A. A. Rambaut.* "On the Effect of Atmospheric Dispersion on the Position of a Star."

The following gentlemen were elected Fellows of the Society:—

*George Cox Bompas*, 121 Westbourne Terrace, Hyde Park, W.; *Bryan Cookson*, Magdalen College, Oxford; and *Lieut. Basil Taylor*, R.N., H.M.S. 'Blake,' North American Station.

The following Candidates were proposed for election as Fellows of the Society:—

*Edwin Bare*, Ruthven Villa, Hainault Road, Leytonstone (proposed by James Glaisher).

*Vincent Joseph Bouton*, B.Sc., 9 Lansdowne Terrace, Hampton Wick (proposed by Arthur Cottam).

*Henri Deslandres*, D. ès Sc., Astronome-adjoint à l'Observatoire de Paris (proposed by Capt. W. de W. Abney).

*Comte A. de la Baume Pluvinel*, 7 Rue de la Baume, Paris (proposed by Capt. W. de W. Abney).

*George Darley Lardner*, Commissary-General, 6 Prince's Road, Wimbledon (proposed by R. A. Gregory).

*C. W. D. Perrins*, Davenham Bank, Malvern (proposed by the Rev. F. J. Eld).

*Charles A. Post*, 21 Washington Square, New York, U.S.A. (proposed by Harold Jacoby).

*Charles Roberts*, 6 Bramerton Street, King's Road, Chelsea, S.W. (proposed by Adam Hilger).

## BRITISH ASTRONOMICAL ASSOCIATION.

THE second meeting of the current session of the British Astronomical Association was held at University College, Gower Street, on Wednesday 28th of November, Mr. E. Walter Maunder, President of the Association, in the Chair.

The election of 31 new members by the Council was confirmed by the Meeting, and the names of 16 candidates for Membership were read and suspended. The election of 21 new members by the newly-formed West of Scotland Branch was also announced. The President also stated that the Council had issued a warrant for the formation of a Branch of the Association in New South Wales.

*Mr. Petrie* read a paper by Mr. Leo Brenner on "Moderate or Giant Telescopes; Refractors or Reflectors?" The writer maintained that while giant telescopes were necessary for difficult double stars, faint objects, celestial photography, and comets, none of the great telescopes had showed so much detail on Mars as Schiaparelli's 8-in. and 18-in. refractors, and he contended that planets and the Moon were best observed with refractors of 7 to 10 inches, and he further argued for the superiority of refractors over reflectors.

*Mr. E. Holmes* thought that Herr Leo Brenner's paper must be taken in connection with a number of letters he had recently written about the performance of his new 7-in. object-glass. Of course, seeing faint stars and faint detail was as much a matter of clear atmosphere and sensitive retina as of size of telescope. After criticizing the common expression "the light-gathering power of a telescope," Mr. Holmes urged that in the separation of close double stars nothing could compensate for small aperture, and it was surprising that eminent men should so often forget in their own case the theories they propounded for the guidance of the less instructed. There was nothing more certain than the relationship which existed between the disc which represented any luminous point on their retina, or any focal image, and the aperture it was seen with. Unless the aperture was sufficient to separate the two discs of a double star in the focal image, it was impossible for them to be divided by that aperture at all. Out of the rather mixed lot of double stars in Herr Brenner's list, there were some pairs that could not possibly be divided by a 7-inch object-glass.

*Mr. G. M. Seabroke* remarked that he had used both a refractor and reflector, and considered that each had its special advantages for certain kinds of work, but that the reflector, equatorially mounted, of necessity the cheaper instrument, was the best for amateurs, as coming within their financial means.

*The President* considered that Herr Brenner was to be congratulated on being so extremely satisfied with his instrument; but his experience was that for every kind of observation—

planetary as well as any other—the quality of the instruments being assumed equal—the comfort of using a larger telescope was very great indeed.

*Mr. A. C. D. Crommelin* read a paper on "The Recurrence of Eclipses," explaining the three cycles of recurrence—the 4-year cycle, the very close 18-year cycle (the ancient "Saros" of Chaldean astronomers), and the long cycles of 1154 and 1805 years recently investigated by M. Oppert. Mr. Crommelin also exhibited a map of the north of Norway, copied from "Cammermeyer's Reisekarte" of North Norway, and called attention to the advantages of Vardö as a station for observing the Total Solar Eclipse of August 1896.

A number of photographs of the Corona taken by the English Eclipse Expedition of 1893 were thrown on the screen, and also photographs of the last transit of Mercury in 1891, and the transit of Venus in 1874.

*Mr. Overstall* explained a new and simple appliance invented by Major T. A. Skelton for obtaining sidereal time without a sidereal clock. *Mr. Hardy* exhibited a model of a portion of the Moon, and also a small camera for taking "snap-shots" at the Sun and Moon. *Mr. Sidney Hodges* exhibited a beautiful oil-painting of the Moon, and a slide of one of the Lick photographs of the Moon in similar phase was thrown on the screen for comparison.

The Meeting then adjourned.

---

## ROYAL METEOROLOGICAL SOCIETY.

The monthly Meeting of this Society was held on Wednesday evening, December 19, at the Institution of Civil Engineers, Great George Street, Westminster, Mr. R. Inwards, F.R.A.S., President, in the Chair.

Twenty-six gentlemen were elected Fellows of the Society.

Mr. H. Southall, F.R.Met.Soc., read a paper on "Floods in the West Midlands," in which he gave an interesting account of the great floods which have occurred in the rivers Severn, Wye, Usk, and Avon. He has collected a valuable record of the floods on the Wye at Ross, which he arranges in three classes, viz.:—(1) primary, or highest of all, those of 14 ft. 6 in. and above; (2) secondary, those with a height of 12 to 14½ ft.; (3) tertiary, those with a height of 10 to 12 ft. The dates of the floods above 14 ft. 6 in. are as follows:—1770, November 16th and 18th; 1795, February 11th and 12th; 1809, January 27th; 1824, November 24th; 1831, February 10th; 1852, February 8th and November 12th. The height of the recent flood on November 15th, 1894, was 14 ft. 3 in., which was higher than any flood since November 1852. The flood on the Avon at Bath on November 15th, 1894, is believed to have been the highest on record.

Mr. R. H. Scott, F.R.S., gave an account of the proceedings of the International Meteorological Committee at Upsala in August last, with special reference to the recommendations then adopted as to the classification of clouds and the issue of a cloud atlas.

A paper by Mr. S. C. Knott was also read, giving the results of meteorological observations made at Mojanga, Madagascar, during the years 1892 to 1894.

---

## OBITUARY.

Father Denza.—Francesco Denza, born in Naples on June 7, 1834, of respectable middle-class parents, there entered in early youth an Order of Reformed Franciscans, which he afterwards exchanged for the Barnabite Order. At the College of Macerata he attained such proficiency in mathematics as to be able to take the master's place in teaching the class. In Rome he combined his favourite studies with his theological course, and became the pupil of Father Secchi in astronomy and meteorology. At the College of Moncalieri he founded the Meteorological Observatory, and by the publication of a monthly bulletin gave an impulse to the study of that science in Italy. He first determined the magnetic elements in many of the Italian ports, as well as on the coasts of Dalmatia and Africa, and was the inventor of several useful meteorological instruments. By his observations of falling stars and the attention he drew to the subject, he co-operated in providing the materials from which Professor Schiaparelli deduced his celebrated theory of those bodies. Charged by the Pope with the restoration of the ancient Vatican Observatory in the Gregorian Tower, he adapted it so successfully to the requirements of modern astronomy that he was able to take part in the international work of charting the heavens. The decoration of the Legion of Honour was bestowed on him in recognition of his share in this work, to which the last four years of his life were devoted. He wrote many papers on meteorology and physics, as well as a volume entitled 'The Harmony of the Heavens,' which went through many editions. He had never entirely recovered a shock of apoplexy which attacked him in Turin some years ago, leaving partial paralysis of one side as its result; and his death on December 13 was caused by a recurrence of the same malady, which carried him off in a few hours. E. M. C.

---

Charles Frederick William Peters, the only son of the celebrated astronomer, C. A. F. Peters, was born on April 16, 1844, at Poulkova, passed his childhood at Koenigsberg and his youth at Altona. Inspired with love for natural science and, by the example of his father, filled with enthusiasm for astronomy, he devoted his life to this science, and was appointed Astronomer at the Observatory of Hamburg in 1867, of Altona in 1868, and of Kiel in 1873. In April 1888 he was appointed Director of Bessel's well-known Koenigsberg Observatory and at the same time Professor of Astronomy at the Koenigsberg University.

At the beginning of his astronomical career Dr. Peters made, besides the regular observations, careful calculations of the orbit of the planet Sylvia and of several comets. He edited his well-known book of tables for reduction of observations often used in German observatories. Later, in 1886, he successfully calculated the orbit of the double star 61 Cygni, whose motion hitherto had been thought to be almost rectilinear.

Soon Dr. Peters devoted himself to geodetical investigations. In the years 1869–71 he made valuable pendulum observations, and determined the length of the seconds pendulum by reversion apparatus at Altona, Berlin, and Koenigsberg, and by Bessel's pendulum apparatus at Koenigsberg and at Gueldenstein near Kiel. He participated diligently in the determination of difference of longitude between Altona and Kiel, and wrote a history and criticism of standard Toises.

Then he applied himself to the study of chronometers, and determined the influence of magnetism and of humidity of the air on the daily rate of chronometers. During the period 1883–88 he superintended the naval chronometer observatory at Kiel.

New editions of Sawitsch's book on 'Practical Astronomy' and of Mueller-Pouillet's 'Cosmical Physics' have been almost re-written and published by Prof. Peters. Moreover, he has written numerous papers on popular astronomy.

He died 1894 December 2, at Koenigsberg, from the effect of a heavy nephritic malady. His amiable character, his sincere and honest disposition acquired for him many true friends among his colleagues, who all, with his wife and his children, sincerely regret his early death. J. F.

---

A. Cowper Ranyard.—Whilst the Royal Astronomical Society was holding its Meeting on Friday, December 14, there passed away one of its Fellows, who, from his devotion to science and the attractiveness of his character, leaves a gap that will not readily be filled.

Arthur Cowper Ranyard was born in 1845, and was a pupil of Professor De Morgan. He was educated at Cambridge, where he graduated in 1868; and in 1871 he was called to the Bar at Lincoln's Inn. But though thus taking up the Law as his profession, he had a strong attachment to mathematics and astronomy, and when only 18 years of age had been elected a Fellow of the Royal Astronomical Society. A few months later he entered into co-operation with George De Morgan in the starting of the London Mathematical Society, of which he became one of the Honorary Secretaries.

In the Royal Astronomical Society he was soon placed on the

Council, of which he was a Member, with the interruption of only 4 years, from 1872 to the time of his death. From 1874 to 1880 he also served as Hon. Secretary, an office for which his cheerful industry and unfailing courtesy especially fitted him.

Of his astronomical work, mention should be first made of his preparation, whilst Secretary of the Royal Astronomical Society, of Volume XLI. of the 'Memoirs.' The work, the collation and arrangement of the observations of total Solar Eclipses up to and including that of April 6, 1875, was one in which he took the greatest interest, and he carried it out with a skill, a thoroughness, and a conscientious industry beyond all praise.

Solar physics had always appealed strongly to him, and he undertook three expeditions at his own expense to observe various eclipses, viz. those of December 1870, July 1878, and April 1882. He studied the forms of the coronal details with much interest, and argued strongly that they bore witness to ejections from the Sun into a resisting medium—not, however, into a medium constituting a statical atmosphere, the upper layers compressing the lower. He contended that not even the prominences and chromosphere formed a solar atmosphere in such a sense.

The recent researches of Hale and Deslandres rendered him anxious to help in the exploration of the new fields they had opened, and he had a spectroheliograph constructed for himself, which he lent to Prof. Hale for his Etna expedition. He was looking forward to years of hard and successful work with this instrument; but he had been seized by the malady which proved fatal before it reached England, and the cases had not been even opened at the time of his death.

Next to solar physics, the vast questions relating to the structure of the stellar universe had perhaps the greatest attraction for him; and in the pages of 'Old and New Astronomy' and of 'Knowledge' he showed how clearly and carefully he had thought on the intricate problems the subject offers.

His undertaking the completion of the 'Old and New Astronomy' was very typical of the generous spirit which formed so marked a feature of his character. Practically it meant the devotion of years of hard work simply to sustain another's reputation. But this was no sacrifice to one who always welcomed so ungrudgingly the success and achievements of others.

As editor of 'Knowledge' he struck out a line for himself, and by the publication of copies of the best astronomical photographs within his reach rendered a most important service to lovers of astronomy and to the science itself.

In the department of photography he had long been a careful experimentalist, having worked with the Earl of Crawford (then Lord Lindsay) in 1872 in the study of photographic irradiation, and later, alone, on the relation between length of exposure, brightness of light, and intensity of photographic action.

He took a keen interest in social and political questions, and during the last three years of his life was a most active member of the London County Council. There is, indeed, reason to fear that his unswerving fidelity to the duties of his position, and the unsparing devotion with which he carried through all that he had to do, contributed not a little to his premature death.

His last illness, though in many ways a particularly distressing one, was borne by him with much patience and courage. Few men will be more sincerely regretted, for no one could be more kindly and generous or more free from the slightest taint of self-seeking. E. W. M.

## *On selecting Suitable Nights for observing Planetary Spectra.*

In the 'Observatory' for November Dr. Huggins has quoted a part of a paragraph from my paper on "The Spectrum of Mars":—

"It is very important, as Janssen pointed out in 1867, that we eliminate as far as possible the effect of aqueous vapour in our own atmosphere. The observers do not seem to have taken this factor into account (except Janssen, the details of whose observations appear to be unpublished)."

So far as the above statement, taken by itself, is concerned, I agree with Dr. Huggins that it is very "far from being correct." But the passage quoted is incomplete, and its apparent meaning bears very little relation to what I really said. Dr. Huggins overlooked and omitted the important first half of the sentence, but quoted the subordinate second half, and naturally therefore missed the point. If we place the omitted half-sentence at the beginning of the quoted passage the meaning will become clear. In enumerating the advantages of Mt. Hamilton for making such observations, I mentioned:—

"(4) The very dry summer air prevailing here. The average relative humidity is very low at Mount Hamilton for the months of July and August. In many years it is less than 35 per cent. There is no difficulty in selecting nights for observing the spectrum of Mars when our relative humidity is not more than 20. This is a very important factor, since in examining Mars' spectrum for evidences of aqueous vapour it is very important, as Janssen pointed out in 1867, that we eliminate as far as possible the effect of aqueous vapour in our own atmosphere. The observers do not seem to have taken this factor into account (except Janssen *, the details of whose observations appear to be unpublished). By examining the contemporary weather data, I find that some of the observations were made when the relative humidity was 81, 85, and even 90. All the principal published observations were made where the average relative humidity at those seasons of the year is something like 80."

---

* To avoid misunderstanding, I explain that this is meant in the sense of "except possibly Janssen," since we have not the details of his observations and they appear to be unpublished.

It will be seen that the subject of that paragraph is *relative humidity*. It will also be seen that the half-sentence overlooked by Dr. Huggins—"This is a very important factor, &c."—refers to the factor *relative humidity*. It must also be evident that the expression quoted by him—"The observers do not seem to have taken this factor into account"—refers to the factor *relative humidity*, and not to aqueous vapour in general. I do not understand that Dr. Huggins did take the factor relative humidity into account. Its importance does not seem to be generally understood, and I shall briefly state its bearing upon the problem.

In order to eliminate the effects of our own atmosphere and whatever it may contain, it is sufficient, theoretically, to observe the spectra of Mars and the Moon when these bodies have equal altitudes; and Dr. Huggins will find in the paragraph next following the one from which he quoted that I gave the observers full credit for employing that method when I wrote "the observers sought to eliminate the effect of our atmosphere and its aqueous vapour by observing the lunar spectrum when the Moon was at the same altitudes."

Now while that method is theoretically sufficient, practically it is not. It would be theoretically sufficient to observe the Moon and Mars *as soon as they appear above the horizon*; but practically every observer would wait, or ought to wait, until they are near their maximum altitude, in order to eliminate as far as possible from both spectra the effects of our own atmosphere. If, for example, the altitudes of these bodies at one time are only 25° and at another time are 60°, the relative thicknesses of atmosphere passed through by the rays of light are about as 2 to 1, and clearly there would be a great advantage in observing at the altitude 60°. Similarly, if the relative humidity of our atmosphere at one time is 90 per cent. and at another time is only 45, clearly the latter time should be preferred for observation *.

If it is important to reduce the thickness of the stratum of the atmosphere by observing when Mars and the Moon have great altitudes rather than low ones, it is equally important to observe when the relative humidity of the atmosphere is low rather than when it is high. Janssen deserves great credit for ascending Mount Etna to make observations of Mars' spectrum. By so doing he eliminated nearly half our atmosphere and probably much more than half the aqueous vapour. If that was worth doing, we on the surface ought to eliminate the aqueous vapour *as far as possible* by selecting nights for the observations when the relative humidity is low. W. W. Campbell.

Mt. Hamilton, 1894, Nov. 19.

[In our last number (1894 December, p. 405) Dr. Huggins has already stated that he had overlooked the mention by Professor Campbell of the observations of the Moon by the early observers. —EDS.]

---

* Of course the relative humidity at the surface of the Earth is probably not the same as the relative humidity at higher levels, but the former must be our guide.

---

## *Selenographical Notes.*

BESSARION AND CRATERS NORTH OF KEPLER.—It would perhaps be difficult to find on any portion of the Moon's visible surface such a scarcity of prominent detail as in that part of the Mare Procellarum lying between the meridians passing through Kepler and Marius, and included by the parallels of 5° and 15° of north latitude. On the whole of this area, of 30,000 square miles or more, there is hardly a feature to break the monotony of the apparently dead level grey surface, except those delicate gradations and inequalities of tone which all the "seas" present to a greater or less degree, and the extremities of some of the inexpressibly subtle gossamer-like filaments diverging from Copernicus and Kepler. The bright little ring-plain Bessarion, about 6 miles in diameter, with its smaller but still brighter companion (E) on the north of it, are by far the most conspicuous of the few objects found with the limits just specified; the latter being classified among the most brilliant spots on the Moon, and otherwise remarkable as standing on one of those enigmatical glistening white areas, of the actual nature of which we are ignorant, though we may hazard the conjecture that they represent a deposit of material possessing highly reflective qualities which has emanated from an orifice within the crater-like formations they surround. That associated with Bessarion E can be traced to a distance of 10 or 12 miles on the north of it, its borders being less diffused and more definite than is very often the case. It is elliptical in shape, but the crater is situated much nearer the southern than the northern end of the ellipse, whose major axis lies in a meridional direction. Between E and Bessarion there is a space unoccupied by any light-coloured material; in fact, whether due to contrast or not, this space appears to be manifestly darker than the surface of the Mare in the neighbourhood. Though Bessarion itself is not classed as a light-surrounded formation, there is an unmistakable glimmer traceable for a considerable distance on the south-east of it, and a distinct light area, less extensive, on the same side of it. These appearances may be observed at an early stage of sunrise, as, for example, where the E. long. of the morning terminator ranges from 40° to 45°. The delicate central peak of Bessarion is not visible at this phase. I find it a much more difficult feature than that within Thebit *l*.

On the Mare, some distance north-east of Bessarion, are three craters, A, B, C in Neison's Map XI., extending nearly in a line from north-west to south-east. They are nearly equal in size, all of them being notably larger, but far less brilliant, than Bessarion.

They also rise to some altitude above the grey plain, as is evident from the prominent shadows they cast when the morning Sun has attained a considerable height above their sites. B, the middle crater, like some others in the neighbourhood, has a companion in close contiguity on the east of it, and is associated with a low ridge running from its northern wall towards the north-east. From C, the most easterly of the group, extends in a flat curve, concave towards the north, a row of what appear to be four very small circular mounds, all of which, when observed under a rising Sun at $7^h\ 0^m$ on the 8th inst., displayed a faint shading on their eastern flanks, while that nearest C was seen to be a craterlet of a minute type. I can only identify two of these objects with any that figure in Schmidt's map, and Neison only shows one which can be regarded as belonging to this curious linear group.

North of these objects, in N. lat. 19°, and east of Brayley, lies another group of four smaller craters, also ranging from north-west to south-east, of which that marked *d* by Neison is the most prominent and the most easterly, and is the only one he shows. North-west of *d*, and very near it, there is a small cup-shaped depression, with a rim only on the north side of it, which does not appear in any of the maps. It was about half-filled with shadow at $7^h\ 30^m$ on December 8, and though somewhat obscure was as easily seen as its neighbours of about the same size. Between it and Brayley is a pair of craterlets, only shown by Schmidt, with two others of a smaller type south of them, unrecorded. The bright ring-plain Brayley is drawn both by Schmidt and Neison without any detail on its border, but I have more than once suspected the existence of a small circular projection on the west wall, which was seen very distinctly on December 8.

Beaumont House, Shakespeare Road,
Bedford, 1894, Dec. 19.

T. GWYN ELGER.

---

## *Mars.*

[Concluded from vol. xvii. p. 401.]

MR. LOWELL says there has been much scepticism with respect to the Martian canals. Doubtless there has; but has not this scepticism been induced, in great part, by the sensational way in which they have been introduced to the astronomical world?—the drawings showing the canals as sharply defined lines, and the theories put forward to account for their existence, the suggestion that they are artificial, for example, are probably responsible for much of this. But we think that the time has come when this scepticism, or rather scientific doubt, should be dispelled, and the markings, we will not say canals, accepted as true observed facts. It is not scientific to deny, simply because we have not seen, the observations of such observers as Schiaparelli, Williams, Schaeberle, Pickering, and Lowell, who have not only seen these markings, but observing at different times, and in different countries, have made drawings of the same regions, which show a remarkable agreement.

Leaving for the moment the question of what these markings are, whether water-courses or other topographical detail, let us consider the objections that have been urged against their existence. First, it is said, they have been seen at some times and not at others. This ought not to be held a very strong argument against their existence; as it is admitted that they are seen only in the largest telescopes and under the most favourable conditions, a slight change in the Martian circumstances might therefore easily render them invisible; the theory that the markings represent water-courses, fuller at one time more than at another, would seem to afford a satisfactory explanation of the varying of the phenomena. Secondly, the regularity and straightness of the markings have been used as a disproof of their existence; on the other hand, as we see above, this uniformity has led some to regard them as the work of intelligent beings. On this head, Prof. Schiaparelli, without absolutely denying that he thinks they might be thus artificial, instances the many regular geometrical forms which appear in the natural world, from the sphericity of the planets to the symmetry of flowers, and argues that this regularity of the Martian canals is only one more instance of the Geometry of Nature; to which it might be answered that, the geometry in this case is not symmetrical enough. A suggestion, well worthy of consideration, to account for the straightness of the lines was put forward by Mr. E. W. Maunder, in 'Knowledge' for November last, which comes in the end to this:—That the "canals" may really be a chain of lakes, or, to use more guarded language, the straight lines may be successions of spots of varying shapes and sizes, and not necessarily in a very straight line, but that, owing to the difficulty of seeing, these spots combine to form visually a line, straight because it is too difficult to make out the details, *i. e.* the irregularities. Here, then, it appears that the reason for doubt has been introduced because observers depicted the markings with such clearness as left no margin of uncertainty, and their readers, refusing to accept them as they appeared, rejected the fact of their existence altogether.

A third difficulty in the way of belief has come from the observed "doubling." That is, Prof. Schiaparelli and others see, where was a single line, a pair of lines like rails of a railroad; sometimes one line of the pair occupies the place of the original line, but sometimes the pair are on either side of the situation of the first. No one has suggested a physical cause of this gemination, and it is difficult to suggest a cause of any kind except that, may be, the markings are always double, but only under exceptionally good circumstances are they seen as such, which leads us back to our former conclusion, that we are far from knowing the ultimate structure of the planet, but that, at present, we are only able to perceive the average appearance. Finally, as to whether these markings represent water surfaces. It must be said that the theory of Prof. Schiaparelli, of which an abstract is given at the beginning of this, is very plausible, and indeed the flowing of water is almost the first explanation which would occur to one as a reason for the formation of such markings; but this is only theory, and remembering that observation has not yet decisively proved (we refer to the discussion between Dr. Huggins and Prof. Campbell) to what extent water is a constituent of the Martian atmosphere, we feel that observation has not yet pronounced as definitely on the quality of the substance of these markings as on the reality of their existence.

# CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

## *The Perseid Radiant.*

GENTLEMEN,—

In the 'Companion to The Observatory' for 1895 Mr. Denning gives an ephemeris for every second day of the Perseid Radiant, pointing out its shifting from time to time. I think Mr. Denning's own Catalogue, as published by the Royal Astronomical Society in 1890, does not bear out this shifting. I give the Ephemeris with the actual observations below. I include the actual observations on intermediate dates, because these throw light on the accuracy of the Ephemeris. The radiants in parentheses are taken from the column of "Other Nights of Observation" in Mr. Denning's Catalogue ('Monthly Notices R.A.S.' vol. l. p. 410).

| Date. | Ephemeris. | Actual observation. |
|---|---|---|
| | ° ° | ° ° |
| July 19 ...... | 19 +51 | 19 +51 [1] |
| | | (18 +63) |
| July 20 ...... | ...... | (21 +57) |
| | | (18 +63) |
| July 21 ...... | 22 +52 | (18 +63) |
| July 22 ...... | ...... | 25 +52 |
| | | 20 +65 |
| July 23 ...... | 25 +52 | 25 +52 |
| | | (18 +63) |
| July 24 ...... | ...... | 18 +63 [2] |
| July 25 ...... | 27 +53 | 12 +52 [2] |

| Date. | Ephemeris. | Actual observation. |
|---|---|---|
| | ° ° | ° ° |
| July 26 ...... | ...... | (12 +52) |
| July 27 ...... | 30 +54 | 29 +54 |
| | | (32 +53) |
| | | (20 +65) |
| | | (43 +58) [3] |
| July 28 ...... | ...... | 18 +58 |
| | | 27 +55 |
| | | 30 +55 |
| | | 32 +53 (twice) |
| | | (21 +57) |
| | | (43 +58) |

[1] Only observed one year; then deduced from 4 meteors.

[2] Could either of these radiants, which last for several days, have been mistaken for 19° +51° on the 19th?

[3] It will be noted that meteors are now found coming very nearly from the Perseid radiant of Aug. 10.

| Date. | Ephemeris. | Actual observation. |
|---|---|---|
| | ° ° | ° ° |
| July 29 ...... | 32 +54 | 21 +57 |
| | | 31 +54½ |
| | | (43 +58) |
| July 30 ...... | ...... | 12 +52[4] |
| | | 32 +53 |
| | | (8 +52) |
| | | (11 +47) |
| July 31 ...... | 34 +55 | 35 +54[5] |
| | | 43 +58[5] |
| Aug. 1 ...... | ...... | 36 +56[6] |
| | | (32 +53) |
| Aug. 2 ...... | 36 +55 | 33 +55 |
| | | 35 +54 |
| | | 39 +55 |
| | | (20 +58)[7] |
| Aug. 3 ...... | ...... | 40 +56 |
| Aug. 4 ...... | 38 +56 | 20 +58 |
| | | 37 +57 |
| Aug. 5 ...... | ...... | 42 +57[8] |
| | | (43 +59) |
| Aug. 6 ...... | 40 +56 | 31 +49 |
| | | (42 +55) |
| Aug. 7 ...... | ...... | 18 +63 |
| | | 40 to 43 + 55 to 58[9] |
| Aug. 8 ...... | 42 +57 | 41 to 43 + 55 to 57[10] |
| | | (43 +59) |
| Aug. 9 ...... | ...... | 44 +55 |
| | | 46 +58 |
| Aug. 10 ...... | 45 +57 | 42½ to 45 + 54 to 59[11] |
| Aug. 11 ...... | ...... | 45 to 48 + 57 to 57½ |
| | | (30 +46) |
| | | (46 +58) |
| | | (43 +59) |
| Aug. 12 ...... | 47 +57 | 48 +57 |
| | | 50 +55 |
| | | (46 +58) |
| | | (8 +53) |
| Aug. 13 ...... | ...... | 49½+57½ |
| | | 52 +57 |
| | | 51 +58 |
| | | (30 +46) |
| Aug. 14 ...... | 50 +58 | 53 +57 |
| | | (5 +54) |
| | | (32 +50) |
| Aug. 15 ...... | ...... | ...... |
| Aug. 16 ...... | 53 +58 | 60 +59[12] |

[4] Three of these probably belong to a radiant not well defined at about 10° +50°, which is active during most of July. It seems distinct from one at about 12° +70°, which is also active for a considerable time. (Not included in this table.)

[5] True and false Perseids. But which is which? The late Padre Denza observed a copious shower from the usual August radiant on the 31st of last July.

[6] Observe the persistency of the radiant at 32° +53°. See, too, Aug. 6, 11, 13, 14.

[7] The persistency of the radiant at about 20° +60° is also noteworthy. See, too, Aug. 4, 7.

[8] Hardly different from the radiant on Aug. 10.

[9] Observations becoming numerous are thus classed.

[10] No change from 7th. Same mean.

[11] The radiant is diffused or varies from year to year, or else the observations cannot be regarded as very accurate. In 1878 Mr. Denning found two radiants separated by some degrees.

[12] From the 10th to the 16th the observations look like a shifting of the radiant, but a shifting considerably greater than that given in the Ephemeris. The observations, however, are hardly numerous enough for a decisive result.

I stop at Aug. 16 with Mr. Denning, but he met with meteors from 40° +59° on Aug. 20 and 21 and from 32° +50° on Aug. 23. Under these circumstances my verdict is "Not proven."

Truly yours,
W. H. S. MONCK.

[Mr. Monck has raised this question before. We print this letter because it seems to us to show unmistakably the shifting of the radiant, from evidence adduced by a declared opponent.—EDS.]

## Chronology and Eclipses.

GENTLEMEN,—

Julius Capitolinus mentions a great eclipse of the Sun which occurred during the first year of the reign of the Younger Gordian. Gibbon, in his history of the 'Decline and Fall of the Roman Empire,' gives A.D. 237 as the first year of his reign; while later historians place the beginning of his reign in the year A.D. 238. There is no doubt that the place of the Younger Gordian in the succession of Roman emperors has been correctly determined by historians, but it does not necessarily follow that his place in chronology is known with any greater accuracy than is that of Vespasian, Augustus, or Julius Cæsar. In some recent papers on the subject of "Chronology and Eclipses," in the 'Astronomical Journal,' the writer has endeavoured to show, from astronomical considerations, that the reigns of the early emperors of the Roman Empire should be placed one year earlier in chronology. But unfortunately there was a certain degree of ambiguity in his conclusions, arising from the fact that the eclipses of two consecutive years would almost equally well satisfy the conditions of the problem, in so far as those conditions were known.

For example, the beginning of the reign of Vespasian is determined by the great night battle of Cremona; and the date of the battle is fixed by means of an eclipse of the Moon which occurred at the same time. Now this battle has been assigned by historians to each of the years 68 and 69 A.D., because there was an eclipse of the Moon in each of those years, visible at that place, which would represent the known facts of the case with nearly the same degree of plausibility, since the actual time of the night at which it occurred was not stated by the historian. The year A.D. 69 has, however, been usually assigned as the beginning of the reign of Vespasian.

In like manner the beginning of the reign of Tiberias, which dates from the death of Augustus, has been assigned to each of the years 13 and 14 A.D. The death of Augustus was followed by a sedition of three Roman legions in the province of Pannonia; and this sedition was quelled mainly through the influence of an eclipse of the Moon which took place a short time afterwards. But, as in the case of Vespasian, there was an eclipse of the Moon in the autumn of each of those years under circumstances so nearly similar that each of them has been taken as the year of his death. The eclipse mentioned by Julius Capitolinus is therefore doubly valuable, for it not only determines the first year of Gordian's reign, but it also removes the uncertainty as to the dates of the accession of Vespasian and Tiberias, and of the death of Augustus and Julius Cæsar. It is also free from ambiguity, as there was only one large eclipse of the Sun visible at Rome between the years A.D. 234 and A.D. 240; and that was the eclipse of A.D. 237, April 12. At that date I find the Sun set at Rome with 10·63 digits eclipsed. The first year of Gordian was therefore A.D. 237; the first year of Vespasian was A.D. 68; while the death of Augustus Cæsar and Julius Cæsar occurred in the years A.D. 13 and B.C. 45 respectively.

Nickolaas Struyck, in vol. i. page 353 of 'Commentationes Theologicæ,' edited by Jo. Casp. Velthusen, C. F. Kuinoël, Ruperti, and others (Leipzic, 1794–99), mentions a similar eclipse of the Sun which occurred a short time after the celebration of the Olympic Games. This must have been the eclipse of A.D. 240, August 5, which passed over the sacred territory of Olympia in the early morning of that day, since there had been no other eclipse under similar conditions during the preceding twenty years. The year A.D. 240 was therefore the first of the *two hundred and fifty-fifth olympiad*; and since Censorinus states that he wrote his work 'De Die Natali' in the second year of the *two hundred and fifty-fourth olympiad*, he must have written it in the year A.D. 237, instead of 238, as has heretofore been generally supposed. It therefore follows that the history of the early Roman Empire should be placed one year earlier in chronology; and this, taken in connection with the fact that the first olympiad was celebrated in the year B.C. 777 instead of B.C. 776, will serve to very generally harmonize the statements of the Grecian and Roman historians.

The poet Pindar, who lived between the years B.C. 520 and 440, speaks of an eclipse of the Sun which he had witnessed, and which must have been total (see Bergk's 'Poetae Lyrici Graeci,' frag. 107).

Pindar's residence must have been at Thebes in Bœotia, whose longitude is 23° 20′ east, and latitude 38° 20′ north. Now the only total eclipse of the Sun which was visible in that part of the world during the lifetime of Pindar was that of B.C. 463, April 30, which I have computed, more for the purpose of testing the correctness of the theory of eclipses which I have employed than for fixing a date. I find the shadow of that eclipse, when narrowest, was 2° 20′ in breadth, where it was central at noon; and the line of central eclipse entered the western coast of Greece in latitude 39° 10′, and left the eastern coast in latitude 38° 50′. But since the breadth of the shadow was then at least 2½°, it follows that the Sun must have been totally eclipsed to the whole of Greece between the latitudes of 37½° and 40°. The eclipse took place at $4^h\ 40^m$ in the afternoon, at which time the Sun's altitude was about 25°. The theory, therefore, perfectly represents the observations in so far as they are known.

Yours faithfully,

Cleveland, Ohio, 1894, Dec. 10. JOHN N. STOCKWELL.

## *On the Pulkova Standard Catalogue for* 1885·0.

GENTLEMEN,—

In the November number of the 'Observatory' I have just read an article signed W. G. T., concerning the Pulkova "Declinaisons moyennes des étoiles principales pour l'époque 1885·0." As the statements of this article contain several errors, I must beg leave to insert the following remarks on the matter in question.

The assertion of Mr. W. G. T. that our Catalogue contains but 40 stars, when their number in fact exceeds 400, I am ready to accept as a misprint, although another statement of similar character is considerably less intelligible. Mr. W. G. T. says: "It does not, however, appear to us that 8 can be considered an excessive number of observations spread over 10 years, upon which to establish a first-class fundamental position; we should much have preferred to have found 8 observations in every year." On this point it must be mentioned, first, that it has never been established as a principle at Pulkova to collect, for a catalogue position, an excessive number of observations. The gain of such a number, as long as we have the conviction that all the sources of systematic errors are eliminated, seems somewhat problematic; but that, without abandoning this point of view, I have succeeded in bringing up the minimum number of observations of a star from 4 (as in the Catalogue of 1865) to 8 in the present, probably also Mr. W. G. T. will consider a real progress. Mr. W. G. T. would, further, if he looked into our Catalogue with but a little attention, certainly find that the observations can hardly be spread over 10 years for the stars in general. The series begins in 1882, and in the Catalogue it may be seen that for more than 70 per cent. of the stars the mean epoch of the observations falls more or less *before* 1885·0. During the last years of the series observations are made of only a few stars, and these, generally, for other purposes than catalogue positions; I saw no reason, however, to exclude them in forming the definitive positions. In expressing the desire that all our—about 400—standard stars had been observed at least eight times in every year with the Vertical Circle, Mr. W. G. T. evidently regards this wish as a justifiable one. Then we are forced to the conclusion either that he, in collecting observations, can establish such a record, whereby he will leave far behind all observing astronomers hitherto known, or he has—which is perhaps more likely—spent no attention on our Vertical Circle and the use of this instrument.

But still more surprising are the statements of Mr. W. G. T. relative to the refraction, by means of which the observations of the present series are brought into the best accordance. He says: "As a support of this alteration he (Nyrén) gives comparisons of the 1865 and 1885 star-places, with and without the corrections; but as in a previous part of the introduction to the volume he has expressly stated that he considers the 1865 Catalogue is open to the grave objection that its places depend on too few observations, it seems somewhat surprising that he should finally appeal to its judgment in so important a matter." Here Mr. W. G. T. is completely in error; with no word, with no figure, have I appealed to the judgment of the 1865 Catalogue to justify the alterations of the constants of our "Tabulæ Refractionum." But what has hindered us from doing so is not the circumstance, which in Mr. W. G. T.'s opinion would make such an appeal not to be trusted. In defiance of the weakness of individual positions, there can be no doubt that the mean of several thousands of observations with our instrument should give an important testimony as to the refraction. But in comparing two catalogues, based on observations made in quite similar conditions with the view of obtaining in this way a control of the refraction employed, we have only intended to show that such researches are beyond our competence. The differences of the two Catalogues are given with the purpose partly to establish, summarily, a relation of one catalogue to the other, partly to show the mean influence of the correction of refraction upon the declinations of the 1885 Catalogue. The first purpose needs no words of explanation; the other is expressly stated in the preface to the Catalogue, where is said: "L'effet combiné des deux corrections se manifeste dans le rapport des Catalogues pour 1865 et 1885 en les comparant *sans* et *avec* cette modification des tables de refraction."

Yours faithfully,
Pulkova, 1894, Dec. 14. M. Nyrén.

[For the misprint of 40 for 400 we are entirely responsible. Also in the line following on p. 364 read "continues" for "combines."—Eds.]

## *De Vico's Periodical Comet* (1844 I.).

Gentlemen,—

This comet was discovered by Signor Francesco de Vico, on August 22, 1844, at the Collegio Romano, when it was situated in about 357° −23°. Towards the end of September it became visible to the naked eye, and when examined with telescopic power exhibited a bright stellar nucleus and a short tail. The object continued to be observed until December 7, so that its duration of visibility included a period of 107 days. The motion of the comet, a few weeks after its first perception, showed a striking departure from the path indicated by the parabolic elements which had been computed, and an elliptical orbit was substituted by several astronomers. Nicolai gave 1992 days as the resulting periodic time, Brunnow 1996, Hind 1980, Faye 1993, and Schubert 1923. These values correspond to nearly 5½ years, and the comet was expected to return in 1850 and in 1855; but though, in the latter year, the conditions were favourable to its re-observation, nothing of it could be seen. Nor could it be found at the subsequent returns of 1861, 1866, &c., so that observers had practically given up the search, the prospect of success being extremely doubtful.

Now, however, years after the object had been regarded as lost, comes the welcome announcement, from M. Schulhof, that the comet discovered by Edward Swift in Aquarius on November 20 last shows such a resemblance of orbit-elements with De Vico's comet of 1844, that it may be regarded as a veritable return of that body. Its redetection, after having for 50 years eluded all attempts to pick it up, must be regarded as a very interesting and important fact in this branch of astronomy. Among other things it proves that the non-detection of a periodical comet during several returns after its first recorded apparition by no means signifies that the computations are erroneous, or that the comet has necessarily disappeared or been drawn from its assigned course by the effects of planetary perturbation.

It seems, therefore, desirable not to expunge well-determined periodical comets, observed at only one return to perihelion, from the list of such bodies, the probability being that they will turn up again. Apart from the example furnished by De Vico's comet, which was not seen at all during 8 successive returns, we have that of Pons's comet of 1819 (III.), which came to perihelion six times unnoticed between 1819 and 1858, when Winnecke swept it up and identified it. Of course these Jovian comets are not favourably presented at every return; it happens frequently in the case of those which, like De Vico-Swift and Pons-Winnecke, revolve in about 5½ years, that every alternate return cannot be verified owing to the relative positions of the Earth, comet, and Sun. Thus though De Vico's comet must have returned in about 1850, '55, '61, '66, '72, '78, 83, '89, the conditions for observing it were really favourable in only the three years 1855, '66, and '83, when, however, it appears to have quite escaped detection. At its recent apparition it nearly succeeded in eluding us again, for when it was picked up it was 47 days past perihelion and becoming rapidly fainter. According to Dr. Leuschner, of the Lick Observatory, the date of perihelion was Oct. 4, 1894, so that the whole interval, from the perihelion of Sept. 2, 1844, comprises 18,294 days, or a mean periodic time for the comet of 2033 days for 9 revolutions.

The observational career of De Vico was brilliant, if brief. His cometary discoveries were numerous in the years from 1844 to 1846. He found a second periodical comet in 1846, February 20, for which a period of 73¼ years was computed, whence the year 1919 may witness its return. He died on November 15, 1848, when only 43 years of age. Yours faithfully,

1894, Bristol, Dec. 24. W. F. Denning.

## *The supposed Chinese Eclipse of the 'Shu Ching.'*

Gentlemen,—

As the question of this eclipse (which, if real, is by far the oldest one of which there is any record) has been brought up in the 'Observatory,' I should be glad to be allowed a few words about the latest investigations with regard to it.

In the eleventh volume of the 'Memoirs' of the R. A. S., Rothman discussed the question, and contended for an eclipse the date of which was October 13, B.C. 2128, and which he calculated to have been of the magnitude of 10½ digits in the northern part of China. The date of his communication is 1837, and the volume was published in 1840. In 1863, the late Assistant-Secretary of the R. A. S., Mr. Williams, made, at the request of Dr. Hind, a careful examination of the passage in the 'Shu Ching' and also of other historical works in which the eclipse is mentioned. It is said to have occurred in the first year of the reign of Chung-Kang, and Williams came to the conclusion that its most probable date in our chronology was B.C. 2158; but, as there was some doubt about the date of the accession of Yu (the founder of the dynasty and grandfather of Chung-Kang), he considered that that of the eclipse might be earlier by perhaps four years, leaving it for others to determine whether there was a solar eclipse visible in China at that time. Oppolzer, however (his investigation is published in the 'Monatsberichte' of the Berlin Academy of Sciences in 1880), contended for an eclipse calculated by him to have taken place on October 21, B.C. 2137. But Herr Ginzel has just called my attention to an able paper by Herr Schlegel and Prof. Kühnert, which appeared in the 'Verhandelingen' of the Amsterdam Academy (Letterkunde Section, part xix.) in 1889. The authors give reasons for considering the time of the year to have been the spring rather than the autumn; and arrive at the result that the eclipse referred to in the 'Shu Ching' was probably one which was annular in China and occurred on the 7th of May, B.C. 2165; but are careful to add the reservation (the paper is in German): "*so fern* die genannten Erwägungen als berechtigt anerkannt werden müssen." The date, it will be noticed, differs by only about seven years from that thought by Williams to be the most likely; and probably the chronology of the period is uncertain to a longer interval than that. Hi and Ho (supposing those to be the names of men rather than of offices) seem to have been accused of failure, not to predict the phenomenon, but to observe it.

Yours faithfully,

Blackheath, 1894, Nov. 21. W. T. Lynn.

## PUBLICATIONS.

Messrs. Longmans & Co. have sent us a copy of the latest examination book* on Astronomy—that is, a book written to help the candidates for the ordinary degree of London and Dublin Universities to convince their examiners that they know something about Astronomy; and from this point of view the book fulfils its purpose. There are not many books of this class, and until a few years ago there was no book that exactly fulfilled the requirements.

---

* 'Elements of Astronomy.' George W. Parker, M.A., Trin. Coll., Dublin. Longmans, Green, & Co., 1894. 5s. net.

Some are too advanced and others not sufficiently comprehensive. The book now before us appears to be a happy mean, and gives just the minimum amount of reading necessary for a pass. The arrangement, style, and type, which are very clear, remind us of Mr. Godfray's book, and, remembering its purpose, the critic must not be too exacting in his expectations. It occurs to us that the explanation of the Foucault pendulum experiment for an intermediate latitude might have been omitted; no one yet has been able to supply a satisfactory *popular* explanation of this, and the principle of the composition of angular velocities seems out of place in a book which professes to require only very elementary mathematics. We might also suggest that in writing of the errors of a Transit instrument it should be mentioned that it is practically impossible to adjust an instrument exactly, and that corrections are applied to the observations for the outstanding errors. This may seem a trivial criticism, but the point would serve for an examination question. The book is well up to date; there are paragraphs on sun-spots, solar rotation, and spectroscopes and spectra, and, what is so essential in a book of this kind, a good collection of examples and examination questions.

Publicazioni della Specola Vaticana. Vol. IV.—This volume, dedicated to His Holiness the Pope, represents recent—and we are sorry to add the last—work done at the Vatican Observatory under the direction of Father F. Denza. The work on the Astrographic Chart has been in full force since 1892 January 27, under Messrs. Lais and Mannucci, and the progress is represented as follows:—

| | | | | |
|---|---|---|---|---|
| 1892 .... | Chart plates | 26 | Catalogue plates | 115 |
| 1893 .... | „ | 121 | „ | 261 |

Beyond these, photographs were made of Nova Aurigæ, Comets Swift (*a* 1892), Holmes, Brooks, and Rordame-Quénisset, of the Orion nebula and the star-cluster in Herculis, &c. A series of photographs of the total eclipse of April 16 was secured by Signor Mannucci.

The great bulk of the volume is occupied by magnetic and meteorological observations. At the end there are 14 engravings from photographs of celestial objects, including the nebula in Vulpecula, nebulæ in Pleiades, nebula in Orion, total solar eclipse 1893 April 16, a fine photograph of the Sun and of the sun-spots of Aug. 7, the micrometer, and a couple of plates showing the Richard Anemometer Register. Great care has evidently been bestowed on the volume.

Kraft und Materie im Raume. A. Turner, Vienna *.—In the introduction to the fourth edition of this work, which has been sent us, although it contains little astronomy, the author enunciates a law which he calls the "Law of Compensation," and cheerfully begins by assuring us that not only must the Nebular Hypothesis of Kant and Laplace be given up, but also that the Law of Gravitation is untenable. We dipped into the book in several other places, but it seemed to us no better than

---

* Theodor Thomas. Leipzig, 1894.

> "Und Neun ist Eins
> Und Zehn ist keins";

and we were inclined to say with Faust,

> "Mich dünkt, die Alte spricht im Fieber."

---

## NOTES.

Comet Notes.—Encke's Comet is now fairly bright, but towards the end of January it gets too near the Sun for convenient observation. The following is a continuation of Dr. Backlund's ephemeris, reduced to 5 P.M. at Greenwich:—

| 1895. | R.A. h m s | Decl. ° ′ | 1895. | R.A. h m s | Decl. ° ′ |
|---|---|---|---|---|---|
| Jan. 4.. | 22 12 37 | 2 34 N. | Jan. 20.. | 21 50 31 | 2 51 S. |
| 8.. | 10 17 | 1 48 N. | 24.. | 35 39 | 5 58 S. |
| 12.. | 6 27 | 0 46 N. | 28.. | 14 53 | 10 15 S. |
| 16.. | 0 16 | 0 42 S. | | | |

The Comet was seen at Greenwich at Dec. 27 and 30, being readily visible with the Sheepshanks Equatorial, aperture 6·7 inches.

It appears almost certain that E. Swift's Comet is a return of De Vico's Comet, 1844 I., for which elliptical elements, with a period of 5·47 years, were found, but which has not been seen since.

Dr. Schulhof discusses the question of identity in Ast. Nach. 3267, and assuming a period of $5^{y}\cdot8$ for the new comet, he deduces the following elliptic elements, the elements of De Vico's Comet being given for comparison:—

| | E. Swift's Comet. | | De Vico's Comet. | |
|---|---|---|---|---|
| Epoch 1894 Nov. $22^{d}\cdot5$ Paris M.T. | | | | |
| M .... | 7° 2′ | | | |
| π .... | 345 20 | 1894·0. | 342° 31′ | 1844·0. |
| ☊ .... | 48 35 | | 63 50 | |
| *i* .... | 2 59 | | 2 55 | |
| φ .... | 34 40 | | 38 7 | |
| μ .... | 612″ | | 650″ | |
| log *a* .. | 0·5088 | | | |

The alterations in the elements agree with those that would be produced by perturbations, and Tisserand's criterion of identity is satisfied. Both elements show a close approach to Jupiter in 1885, and a computation of the perturbations from 1885 to 1894 will be sufficient to decide the question of identity. The comet will approach Jupiter still more closely in 1897, which will make it difficult to predict the circumstances of the next return.

Dr. Schulhof gives the following ephemeris for January (at Paris midnight); the comet will, however, be very faint:—

| | R.A. | | | N. Decl. | | | R.A. | | | N. Decl. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | h | m | s | ° | ′ | | h | m | s | ° | ′ |
| Jan. 4.... | 0 | 21 | 18 | 1 | 52 | Jan. 20.... | 1 | 0 | 44 | 6 | 32 |
| 8.... | | 31 | 21 | 3 | 5 | 24.... | | 10 | 19 | 7 | 37 |
| 12.... | | 41 | 16 | 4 | 16 | 28.... | | 19 | 48 | 8 | 41 |
| 16.... | | 51 | 4 | 5 | 25 | Feb. 1.... | | 29 | 11 | 9 | 42 |

A. C. D. C.

---

Minor Planet Notes.—Three new planets—BK, BL, BM—were discovered by M. Charlois on Nov. 3, Dec. 1 and 19, respectively, each being of the 13th magnitude. The number of Minor Planets known is now 407. A. C. D. C.

---

Those of our readers who have been interested in Mr. Taylor's papers read before the Royal Astronomical Society will be glad to hear that Messrs. Cooke and Sons have constructed a 12½-inch equatorial for Rio Janeiro. The following is extracted from a long article in 'Engineering,' 1894 Nov. 23, where complete details, illustrated by diagrams, are given:—

"We now come to what, after all, is the most important part of a telescope, viz. the object-glass, and in this Messrs. Cooke have recently succeeded in making some improvements which promise to be of high importance. The ordinary so-called achromatic object-glass is composed of two distinct lenses, namely, a concave lens of flint-glass and a convex lens of crown-glass, which by using suitable curvatures enables the optician to combine any two rays of the spectrum. In ordinary telescope work the two rays to be combined are chosen so as to give the greatest amount of light, whilst still preserving a white image. The other rays which are not brought to the same focus as these form a secondary spectrum, and not only is their light lost, so far as the purposes of vision are concerned, but their presence is positively mischievous, as this secondary spectrum must tend to reduce the sharpness of definition.

"By adopting a three-lens form of object-glass, Messrs. Cooke have, however, succeeded in producing a lens which, whilst made of durable glasses and of moderate focal length, is perfectly achromatic. All the rays of the spectrum are brought to the same focus, and the instrument can be used for photographic as well as for visual work, the brightness and sharpness of a star-image being substantially increased in the latter case. The first lens (from without) is convex, and is made of baryta light flint, having a refractive index of 1·5637 for the D ray, and its reciprocal of dispersive power is 50·6. The second lens is of a biconcave shape, and is made out of a new glass known as borosilicate flint, which has a refractive index of 1·54685 for the D ray, and the reciprocal of the dispersive power is 50·2. The third lens is made out of 'bright silicate crown-glass having the following characteristics': refractive index for the D ray, 1·5109; reciprocal of dispersive power, 60·4. By suitably proportioning the various radii of the lenses, the middle negative lens may be made to almost exactly compensate for the dispersion effected by the other two, and this without necessitating any exceptionally great focal length. At a pinch this can be made as small as 15 times the aperture, and there is no difficulty whatever in making a glass with a focal length of 18 apertures.

"A small space is provided between the second and third lenses, the object being to make the correction for spherical aberration as complete as possible; for when the thickness of this space is properly proportioned, there is an entire absence of spherical aberration for all colours of the spectrum."

According to the same article, Dr. Roberts and Prof. Norman Lockyer are highly satisfied with glasses made for them. Dr. Roberts' telescope was 6-inch aperture and 9 feet focal length. Prof. Lockyer tried a 3½-inch.

---

We are sorry to hear that our always cheerful and interesting contemporary, 'L'Astronomie,' will not appear in the new year. In the December number M. Camille Flammarion, the editor, regretfully says good-bye to his readers.

---

Another astronomical periodical, 'Astronomy and Astro-Physics,' which began life under the title of the 'Sidereal Messenger,' is again about to change its name, and in January the first number of the 'Astro-Physical Journal' will be published. The evolution of this journal seems to be as follows:—The 'Sidereal Messenger' was wholly astronomical as the word was understood ten years ago; in 1892 Mr. George Hale, having in his mind the idea of establishing an organ devoted to his branch of the science, viz. the spectroscopic and physical, joined Prof. Payne in the editorship and continued the journal as a twin, as its double name implies. Now Prof. Payne leaves the editorship, and with him the representation of the older astronomy ends, and the new publication will be devoted to physics and spectroscopy, both of the laboratory and of the observatory. The editors are to be Prof. G. E. Hale (to whom contributions are to be addressed at Kenwood Observatory, Chicago) and Prof. James Keeler, with a staff of five assistant editors; and that the publication may be international (it appears that the plans for the new publication were discussed during Prof. Hale's recent visit to Europe) there are to be associate editors—Prof. Cornu, Dr. Dunér, Dr. Huggins, Prof. Tacchini, Dr. Vogel, and Professors Hastings, Michelson, Pickering, Rowland, and Young. Truly a mighty staff!

---

PROF. BARNARD followed up his discovery of an hitherto unknown nebulosity in the neighbourhood of the Pleiades, referred to in our number of November last, by experimenting with a lens of even a shorter focus than that of the Willard which he had previously used. With a lens of a cheap make of 1½-inch diameter and 3½ inches focus, he has taken a photograph of nearly the whole of the constellation Orion with from one to two hours exposure. To his surprise, these pictures showed an enormous curved nebulosity encircling the belt and the great nebula; from the drawing which accompanies his description in 'Astronomy and Astro-Physics' for December, the nebula appears to be of a spiral form, beginning at $\zeta$, and winding with about one and a half convolutions to $\gamma$. On reference, Prof. Barnard found that Prof. W. H. Pickering has previously spoken ('Sidereal Messenger,' vol 9, p. 2) of a great nebula seen on his photographs of Orion and previously unknown. Prof. Barnard's photographs seem to be a perfect confirmation of this, and "the more valuable as it was unconsciously made."

---

THE great gale at the end of December was remarkable, if only on account of serious damage it caused to part of the Royal Observatory equipment. During the height of the gale on the morning of Saturday, Dec. 22, the large shutter of the 18 ft. dome which covers the astrographic twin telescope was torn from its fastenings, and after being blown for some distance above the adjacent buildings, finally came to rest in front of the door of the transit-circle room in the courtyard; the occupant of the dome narrowly escaping injury from the broken ironwork which fell into the shutter-opening. This occurred at $11^h\ 32^m$ A.M., and the greatest wind-pressure (30 lbs. to the square foot) was recorded shortly afterwards. At Greenwich the gale sprang up in the early morning, and speedily became violent, a pressure of 29 lbs. on the square foot being recorded as early as $6^h$ A.M.; but the chief violence of the gale occurred between $11^h$ A.M. and noon, the horizontal movement of the air in that hour, as shown by Robinson's anemometer, amounting to 50 miles. The gale subsided gradually towards evening. From reports published in the public press, it appears to have been of exceptionally violent character. Another gale of less violent character was experienced during the night of the 28th–29th.

---

THE idea that Sun-spots are cavities in the solar photosphere is so generally accepted that Mr. Howlett may find some difficulty in convincing the world to the contrary; although everyone will recognize his assiduity in collecting evidence bearing on the question, and of the value of his handsome contributions to the Royal Astronomical Society. As he says, the question resolves itself into one of careful measurement and tabulation of measures. No doubt Mr. Howlett has tabulated his statistics, and it would be interesting to examine these. It will be remembered that Messrs. De La Rue, Balfour Stewart, and Loewy discussed this point in their first instalment of 'Researches on Solar Physics,' published in 1865, and as result they concluded that of 605 spots measured 456 were in favour of Wilson's theory, namely, that spots were hollows, 74 were against, and 75 were neutral. But, be it said, no account was taken of the position of the nucleus relative to the penumbra when the spot was on the centre of the disc, as it was suggested at the last meeting of the R.A.S. should be done—in fact, the investigation was made on the assumption that the umbra was, on the average, central. The disc was considered divided into six lunes, and the breadth of the penumbra on the side near the centre of disc expressed as a fraction of the breadth on the side from the centre, and the means for each lune taken, and these means were found to be larger for the lunes near the limbs than in the others. In his original investigation of this point Prof. Alexander Wilson (Phil. Trans. 1774) specially pointed out the importance of noting the varying appearance of the spots as they travel across the disc. and the drawing which accompanies his paper, showing the typical case which led to his theory, leaves nothing to be desired in this respect; but the agreement of this drawing with his theory is so exact and so unusual, as to tempt one to suspect exaggeration.

---

As a result of the death of Prof. L. Schwarz, formerly Director of the Observatory at Dorpat, Prof. G. Lewitzky, hitherto Director of Charkow Observatory, has been appointed to Dorpat. Dr. Ludwig Struve, who has been actually in charge of the latter observatory for the past few years, takes Prof. Lewitzky's place at Charkow.

---

WOLSINGHAM OBSERVATORY CIRCULAR, No. 41, states that a very red 8th mag. star of Type IV., not in B. D., was found on Nov. 29 in R.A. $17^h\ 54^m{\cdot}3$, Dec. +58 14′ (1900).

---

MR. MARTH points out that on June 4 and 5 next there will be an opportunity of testing how near to Jupiter a star of 4·3 magnitude can be seen with the naked eye.

---

## FROM AN OXFORD NOTE-BOOK.

IT was known at the time of the death of Prof. Adams that he had left a considerable quantity of MSS.; but it was not known how readily these MSS. might be prepared for publication. The work of examination was undertaken by Mr. R. A. Sampson, of St. John's College, Cambridge (Isaac Newton Student), now Professor of Mathematics at Newcastle-on-Tyne, and he has been earnestly devoting his energies to the task, which has proved a somewhat arduous one, for some two years. In response to a personal request for information as to his progress, Prof. Sampson has very kindly allowed me to state, for the information of the many who feel the deepest interest in the outcome, that he has completely arranged and separated from incidental and preparatory work the following series of memoirs:—

1. Lectures on Lunar Theory;
2. Lectures on Jupiter's Satellites;
3. Solution of the infinite determinant;
4. Some small matters;

of which the first is thoroughly complete and the second well advanced. There is a considerable quantity of MS. still to be examined, and the main hope remaining is that the scheme of Lunar Theory sketched in M. N. xxxviii. p. 44 is more or less completely worked out. "There are large sections of this work," says Prof. Sampson, "but I do not yet know how completely these fragments will fit together." It may be still one or two years ere the examination can be completed.

---

It will be welcome news to those interested in Variable Stars that the late Mr. George Knott has left in MS. his observations of 23 variables, as below:—

U Cephei.
T Tauri.
U Tauri.
R Aurigæ.
S Orionis.
R Canis Min.
V Geminorum.
S Canis Min.
U Canis Min.
U Geminorum.
U Cancri.
R Ursæ Maj.
S Ursæ Maj.
S Coronæ.
R Scorpii.
S Scorpii.
R Cygni.
T Aquilæ.
S Cygni.
U Cygni.
S Delphini.
R Vulpeculæ.
T Cephei.

The observations are recorded with the most beautiful neatness in 23 separate books; and there are also rolls of millimetre-paper with the curves of brightness, which show clearly the accuracy of the observations. The question of the publication of these observations, which are a veritable mine of wealth, is under consideration. Mr. Knott's telescope was a 7⅓-inch refractor, formerly belonging to the Rev. W. R. Dawes, and it is to be hoped that an instrument with such a history may pass into the possession of a worthy successor. I believe it is for sale, together with a transit-instrument and other apparatus.

---

It will probably be news, not only to the world at large but to many Fellows of the Society even, that the Royal Astronomical Society must shortly give a medal or reward of astronomical merit other than their Gold Medal. By the terms of a gift made to them in 1861, and announced in the 'Monthly Notices,' vol. xxii. p. 102, the annual interest of £300 stock, or the accumulations thereof for any term not exceeding seven years, are, at the discretion of the Council to be from time to time given "in the form of a medal, or of money, or both, to the writer of any astronomical work or memoir, the inventor or improver of any astronomical instrument, the discoverer of any new heavenly body, or the promoter in any other way of the Science of Astronomy." The donor (Mrs. Hannah Jackson, *née* Gwilt) reserved the dividends during her life; but her recent death brings the matter under the consideration of the Council some thirty years after the original gift.

---

AN experiment of the gravest importance to artists and owners of valuable pictures is being conducted at South Kensington. Under Capt. Abney's superintendence a gallery has been lighted so as to shut out the most important actinic rays which cause paintings to fade, and yet to show pictures in their true colours! This marvellous result has been attained as follows: daylight is admitted through skylight windows of *coloured* glass, the panes being alternately green-blue and yellow, so that actinic rays are excluded. At the same time the mixture of these colours produces the effect of white light to the eye; and a committee of artists has decided that pictures are seen sensibly in their true colours. The gallery ("Raphael Cartoon" Gallery) has been open to the public some little time, and it is curious to note how completely unconscious the visitors are of anything strange in the lighting.

---

A RECENT memoir by Dr. Dreyer, on the Micrometric Observations of Nebulæ, deals with a subject of great interest. In his introduction he says, "That although nearly all the nebulæ visible in our latitude, and bright enough to be well measured with a refractor of average size, have repeatedly been micrometrically observed during the last forty years, this branch of sidereal astronomy can by no means be considered to be exhausted." Most of us will cordially agree with Dr. Dreyer, and may even go further and wonder whether serious work in this branch has yet been commenced. It is only a few years since Dr. Roberts first took a photograph of the Andromeda nebula and revealed its true structure and possible significance. If we may trust our eyes, we have in this nebula and in others since photographed an actual picture of Laplace's hypothetical nebula; but, as yet we have no measures of precision, which will give us any information as to whether the apparent satellites are really in motion round the central mass. It is in some ways no more easy to make micrometric measures of the confused image on a photographic plate, than it is to make micrometric measures of the ill-defined object seen in a telescope. But by treating photographs taken on different dates in as nearly as possible the same manner and at the same time, it does not seem hopeless to extract some measures of considerable accuracy from pictures of nebulæ. Dr. Dreyer's work has, however, a somewhat different object, viz. the fixing of the positions of nebulæ with reference to neighbouring stars. It has been carried out with a thoroughness for which those familiar with his former work will be prepared. The final outcome is a catalogue of positions of 100 nebulæ for 1890.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

No. 224. FEBRUARY. 1895.

### MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, January 11, 1895.

Capt. W. de W. Abney, C.B., F.R.S., *President*, in the Chair.

*Secretaries*: Prof. H. H. Turner, M.A., B.Sc., and E. W. Maunder.

The Minutes of the last Meeting were read and confirmed.

*Mr. Maunder.* 74 presents have been received since the date of the last meeting. Amongst those calling for special notice are the 'Nautical Almanac' for 1898 with the separate part which is sold for one shilling and gives solely the information necessary for seamen. There are a number of enlargements of lunar photographs by Prof. Weinek. The originals of these pictures, taken by MM. Loewy and Puiseux at the Paris Observatory, are enlarged to a scale twice that of Schmidt's Map. Then we have another instalment of the Astronomische Gesellschaft Catalogue for the zone +40° to +50°. Mr. C. Sharp, who has been liberal to the library on former occasions, has presented two books—one a volume of popular essays on astronomical subjects by Dr. J. R. Hind and the other Mr. Gore's 'World of Space.' Dr. Sheldon sends specimens of experiments in Astronomical Photography with the short-focus lens from an optical lantern. One photograph is a picture of the constellation Orion, and on the original is shown a faint outline of the nebula that Prof. Barnard showed in a recent photograph.

*Dr. Common* read a note on a modified or skew form of Cassegrain telescope. After stating that telescopes of the Cassegrain form, but with the small mirror placed at one side, had been made in Germany many years ago, he mentioned some experiments made about 10 years ago, which, however, were not successful; and then gave the results of his more extended experiments made during the last two years, from which he found that with certain relations of the curves of the two mirrors and the angles of reflection, this form of telescope gave much better results than he had expected. He pointed out the advantages of this form of telescope for spectroscopic work and in the shortening of length. There were also, he stated, other advantages, such as the non-interference of supports of small mirrors with the light from the object, and the consequent freedom of the field from the usual diffraction rays. Some lantern-slides were given illustrating the paper and some large photographs of the Moon taken with trial telescopes.

*Prof. Turner.* It has been remarked that most improvements in practical optics have been due to experiment and not to theory, and I can bear testimony by personal experience to the truth of this remark. Some time back, Dr. Common was kind enough to give me information as to the way the wind was blowing, and taking advantage of his remarks I employed such leisure as I had to looking at the theoretical conditions of oblique reflection. I am sorry to say that I only succeeded in following him at some distance in verifying his experimental results when they were made known to me. To give one single instance of this kind,—the angle which the second reflection should take might have been found out easily from theoretical considerations, but I am bound to say it did not occur to me until after he had determined it practically. [For continuation of remarks, see p. 81.]

*Mr. T. W. Bush.* There is one question I should like to ask in relation to this form of telescope with which Dr. Common seems to have been so successful, and that is, did Dr. Common take pains to produce any special figures for the two mirrors?

*Dr. Common.* With regard to that question, I mentioned that I did not use any particular form of mirror. The convex mirrors were as near as I could get them like the parabolic mirror in the Cassegrain form of telescope. Whether it would be better to give the convex mirror the hyperbolic form, as used in the Cassegrain telescope, I have not yet determined. That does not affect the main question, which is the circular appearance of the stars.

*The Astronomer Royal.* As the President has called upon me I feel bound to make a few remarks, but they must be confined to generalities. The point which strikes me in this is that it is a new departure for the reflector, because the tendency has of late years been to shorten the ratio of focal length to aperture, and now Mr. Common is going in the other direction rather; and I must express satisfaction at seeing that this is leading to a recognition of the value of sufficient focal length in obtaining proper results from any good telescope. It seems to me that experience has shown that when we go to extremes in either direction we lose something in one way or another. Extreme length of course gives great difficulty in manipulation, while an extremely short focus, although it is convenient in some respects, gives too small an image; so as a matter of experience we appear to be led to a conclusion in favour of increased focal length in order to deal with that concentration of light which has somewhat misled those who have adopted very short focal length. I wish to express my deep sense of the very great importance of this new departure in the use of the reflector, or rather the application of the reflector principle. This is a very important advance which has been made, and I am sure the Fellows will join me in giving very hearty thanks to Dr. Common for his very interesting account of it.

*The President.* I do not wish to add to what the Astronomer Royal has said beyond congratulating Dr. Common upon his new departure. I think we may say we have come almost to the limit of sensitiveness in our plates, so that we have one standard-factor with regard to the materials we have for use in these operations. Though we have reduced times of exposure from minutes to seconds, and from seconds to fractions of a second, I think there is very little chance of getting such a like increase in the sensitiveness at the present time. Therefore in practical work with photography it is necessary to work with the present standard in view rather than upon the supposition that any great increase of sensitiveness will arise. I think we ought to thank Prof. Turner for the lucid explanation he has given. It was very interesting to see the way in which he developed his theory. I am sorry for some reasons that that theory did not precede the experimental work which Dr. Common has done so well.

A vote of thanks was accorded to Dr. Common.

*Capt. E. H. Hills* then read a preliminary note on the determination of terrestrial longitudes by photography, and exhibited an instrument that he had had made for that purpose. The instrument was a telescope mounted as an altazimuth on a firm tripod stand, with a camera attached in place of an eyepiece. The method of the determination was first to photograph the Moon on or about the centre of the plate, giving instantaneous exposures at intervals of 1½ to 2½ minutes according to the age of the Moon; then the instrument being left clamped in the same position, to wait until some bright star arrived in the field and then to expose the plate again for about one minute, so that the star would leave a trail on the plate. These exposures to stars are repeated four or five times. Having noted the chronometer-times of exposure and measured and reduced the plate by appropriate formulæ, it is possible to find the difference of Right Ascension of the star and Moon at the time of exposure of the latter, and hence the longitude. Photographs taken at Chatham on the night of October 16, when the instrument was set up on rigid masonry piers, were shown, Jupiter and Aldebaran being the objects photographed at the later exposures.

*Dr. Downing.* I think that Capt. Hills' method will probably be of great service to travellers and others. When I first took up my position as Superintendent of the 'Nautical Almanac,' I grudged the time given to lunar distances, because I knew they were of little value in determining longitude at sea. After reading Dr. Schlicter's paper in the Journal of the Royal Geographical Society, I was inclined to think that something might be made of lunar distances by means of photography; but the difficulty was, according to his experiments, that it was necessary to have the Moon and a star close together, as it was not possible to photograph large angular distances; I think, however, that with recent developments it will be possible to photograph sufficiently large angular distances; but Capt. Hills has shown us how to proceed in a new direction in the matter, which is of course of great practical importance and appears to be susceptible of great accuracy. The only difficulty is whether it would be always practicable to have a convenient star in a proper position with reference to the Moon. I should like to ask him what the difference in declination of the Moon and the object for comparison should be in order to determine the longitude with accuracy?

*Prof. Turner.* This paper is of very great interest, but I do not know whether we are yet within measurable distance of being able to do without lunar distances. I have heard the question asked by naval officers of considerable eminence: "What would you do if being at war and a prize being taken and you were put with other officers of the prize-taking ship on board the prize to navigate her to some port?" The enemy, if they were wise, would probably throw their chronometers overboard before hauling down their flag, and it is necessary for officers to learn lunar distances in order to navigate the prize home if she has no chronometers on board. But I think Capt. Hills has taken us a step further in the direction of doing without lunar distances than we have ever been yet. I was interested particularly in two points which he mentioned. The first was the very simple and natural way in which he managed to make a substitute for a réseau which we have found so useful in measuring the plates of the Astrographic Chart. Capt. Hills has taken the bull by the horns, or rather the needle by the point, and scratched the film so as to get a straight line. I have thought sometimes that the photographs which have been taken, which have no réseau on them, could have the want supplied by having the réseau photographed on a *copy* of them afterwards. Capt. Hills has found another means to the same end. The second point I was interested in was Capt. Hills' remarks about refraction. He says it is important to photograph the objects on the meridian, otherwise refraction will change during the internal exposures. I have only reflected on the matter for a few moments and I may be wrong, but I cannot help thinking that remark is merely evidence of how ingrained in our minds is the Right Ascension and Declination system of co-ordinates. There seems to be no reason why the errors of refraction should affect the observations made at any zenith distances if we chose co-ordinate axes in suitable directions to eliminate this, as Capt. Hills suggests is the case when photographs are taken on the meridian.

*Mr. Inwards.* Speaking as a traveller, I assume that the instrument exhibited is not one that Capt. Hills would take across the Steppes of Tartary or across South America. I think we might have something as strong but lighter. It might be made of iron, I think. The method is an admirable one.

*Mr. Maunder.* What would be the limit of magnitude for a star to trail on the plate?

*Mr. Dyson.* I did not quite follow Capt. Hills in his explanation how he determined the centre of the Moon to measure from.

*Capt. Hills.* Dr. Downing remarked about the measuring of lunar distances up to 90°. It would be impossible to get them on the plate unless the scale were very much smaller, and the measurement would then be more inaccurate. In answer to Mr. Inwards' question, I may say that this particular pattern was designed for experimental purposes entirely. A smaller instrument would do proportionately well. The focal length of this is 19½ inches: by reducing it to 12 inches we should have an instrument weighing 12 or 14 lbs. The one exhibited weighs 55 lbs., and where transport is of no importance, that instrument would be available. As to Prof. Turner's remark about refraction, I do not like to differ from him, but I am measuring the difference of R.A. on the plate and getting the Greenwich time from that difference. A difference in altitude will affect that R.A. unless the Moon is on the meridian. Mr. Maunder asked what the magnitude of the star should be. I do not think that a star fainter than the 2nd magnitude will give a trail, at least in England, but in a clear atmosphere there is no doubt that a much smaller magnitude than that will produce a trail. As to getting the centre of the Moon, I tried several methods, and the method finally adopted is to measure the diameter of the Moon on the plate by the micrometer in different directions.

*The Astronomer Royal.* Why should not the Moon be assumed circular?

*Capt. Hills.* Because it is not circular on the plate. That is owing to distortion. I think it is preferable to measure it direct on the plate.

*The Astronomer Royal.* That is liable to error.

*Capt. Hills.* Yes, you must take a large number of measures.

*The President.* I think we are very much indebted to Capt. Hills for having brought forward this method: I have no doubt it will be very interesting in the future. One or two points struck me. First about the trails. Capt. Hills said in this atmosphere the trail of a star was limited to the 2nd mag. I have just come from a place which is very cold, and the air is very clear, 3500 feet above the sea, and there I have been photographing some trails of equatorial stars; and I find that it is possible to get a trail from an equatorial star of about 7th magnitude. The stars at this altitude are intensely bright, and there is no atmospheric disturbance. In taking lunar distances with a camera of this kind I rather doubt whether it would give results as accurate as the ordinary visual method of taking lunar distances, because there would be a perceptible motion during the time of exposure, and therefore one might not get an accurate distance of the star from the Moon. I think Capt. Hills has made a great advance on the work of his predecessors in this matter.

*The President.* Capt. Hills has referred to Prof. Turner's method of reducing the stars for the Astrographic Chart, and I am glad to say Prof. Turner has a paper on this subject which I will ask him to read.

*Prof. Turner.* This paper to-night runs in the direction of a subject which has been engrossing my thoughts for the last year or two, and I cannot help feeling that the result of that work is an important one. It concerns the method of measurement and reduction of plates taken for the Astrographic Chart. The method of taking the plates has been settled some time since, and all the seventeen instruments are at work and there is no difficulty left about the taking of the plates; but the question of measurement and what is to be done with them when taken is not settled. This question was raised simultaneously with all the questions about taking the plates. Shortly after the Conference of 1887 Dr. Gill contributed an exhaustive essay about the reduction of the plates to be taken by the seventeen observatories, which appeared in the first number of the 'Bulletin' of the Permanent Committee. Since then we have had 6 years' experience, and in such a matter experience is worth much more than theory; and if I mention Dr. Gill's essay it is merely to show how far we have gone since that essay was written. Dr. Gill mentioned three ways, any of which may be adopted for measuring the plates:—First, the method of rectangular co-ordinates; secondly, the measurement of polar co-ordinates (the measures in both these cases to be converted into R.A. and declination); and thirdly the parallactic method of measuring R.A. and declination directly on the plates. He remarked with regard to the rectangular method that it was not so accurate as the other two, and has not simplicity in reduction. The second point of his essay was that he proposed an extremely elaborate investigation for each plate and a method of reduction involving very heavy numerical computations, and he came to the conclusion that the reduction could not be carried out without a central bureau with a budget of £10,000 a year. In my paper I make a proposition which will contrast with those points. I adopt throughout the method of rectangular co-ordinates because it admits of simplicity; and as we have no idea of the life of a photographic plate, since it has not been in use long enough for us to know that, I hope it will be within the capacity of any observatory to make any measures which are required without appeal for extraneous aid. The instrument I exhibit here is a rough model of an old micrometer which has been adopted for the purpose of making some experimental measures whilst the micrometer is being made for permanent use. [Prof. Turner then proceeded to show diagrams illustrating the method of applying corrections to the measures of one plate to make them comparable with the corresponding measures on the adjacent plates, and exhibited specimen results.]

*The Astronomer Royal.* It seems to me there cannot be two opinions as to the great value of the work Prof. Turner is doing in clearing the ground for the utilization of the astrographic work that is being carried out at many observatories. There is no use in taking a large number of photographs unless we are certain they are properly taken, and the results can be made of use at a future time. The reduction of the measures of a photograph is a matter which involves so much labour that it becomes of the greatest importance to simplify it as much as possible. Prof. Turner has done a great service in going into that question, the improvements he has introduced lately having certainly rendered reductions very much easier and simpler, and any lessening of the labour is a matter of the very greatest importance. Mr. Dyson and I have been experimenting upon this matter at Greenwich, and measuring some photographs. We contributed a short note on the subject to show how the work is going on, and I think we have arrived substantially at the same results. We have worked practically on the same method, but with some slight difference.

*Mr. Dyson.* We found that Prof. Turner's method applied very well and gave very accurate results. Of course no one would expect extreme accuracy where so many measures have to be made; but I have no doubt at all that the method of reduction is rapid and tolerably accurate. I think Mr. Turner's method of getting rid of the square terms by means of a diagram is a useful simplification of the process, and, as the Astronomer Royal says, rapidity is of very great importance where there is so much numerical work.

*Sir Robert Ball.* Are the corrections spoken of those which are necessarily involved in the fact that we are projecting the celestial sphere down on the tangent plane? The stars are on the sphere, but the photographic plate represents a tangent plane to that sphere. Is it the correction due to the transference from the sphere to the plane which is involved in the formulæ Prof. Turner has just shown us?

*Prof. Turner.* The correction is from one plane to another. I have rather an objection to referring co-ordinates to the celestial sphere; it rather complicates matters. In transferring them to the sphere all sorts of difficulties arise. In a previous paper I gave reasons for thinking that if the measures are left as shown on the photographic plate they would be far more useful than if they were converted into any other system.

A vote of thanks was accorded to Prof. Turner.

The following papers were announced:—

*H. C. Russell.* "Observations of the Transit of Mercury, 1894 November 10, made in New South Wales."

*Capt. E. H. Hills.* "Preliminary Note on the Determination of Terrestrial Longitudes by Photography."

*Royal Observatory, Greenwich.* "Mean Areas and Heliographic Latitudes of Sun-spots in the year 1892, deduced from Photographs taken at the Royal Observatory, Greenwich, at Dehra Dûn (India), and in Mauritius."

*Royal Observatory, Greenwich.* "Observations of Occultations of Stars by the Moon, and of Phenomena of Jupiter's Satellites, made in the year 1894."

*Royal Observatory, Greenwich.* "Observations of Encke's Comet."

*Prof. T. H. Safford.* "On the Need and Usefulness of Co-operation in Meridian Observation."

*Dr. A. A. Common.* "Preliminary Note on a Modified (Skew) form of Cassegrain Telescope."

*Prof. H. H. Turner.* "On the Measurement and Reduction of Plates for the Astrographic Chart."

*Dr. J. L. E. Dreyer.* "Index Catalogue of Nebulæ found in the years 1888–94, with Notes and Corrections to the New General Catalogue."

*Radcliffe Observatory, Oxford.* "Observations of Comets Sawerthal 1888, Davidson 1889, Wolf 1891, Holmes 1892, Rordame-Quénisset 1893, and Encke 1894, and estimations of Magnitude of Nova Aurigæ."

The following gentlemen were elected Fellows of the Society:—

*J. J. Aubertin*, 33 Duke Street, St. James's, S.W.; *C. J. Green*, M.R.C.S., 10 St. Paul's Square, Preston, Lancashire; *Frederic Hammond*, F.R.I.B.A., 2 Mercer's Road, Tufnell Park, N.; *William Harnett*, 'Cullentra,' Wimbledon Park, S.W.; *Rev. Thomas Roseby*, M.A., LL.D., The Parsonage, Marrickville, N. S. Wales; *Rev. P. H. Waddell*, M.A., B.D., The Manse, Whitekirk, East Lothian, Scotland; and *Robert Wigglesworth*, York.

The following Candidates were proposed for election as Fellows of the Society:—

*G. D. Hirst*, Sydney, New South Wales (proposed by H. C. Russell).

*Samuel V. Hoffman*, 1 Chelsea Square, New York City (proposed by C. Lane Poor).

*H. T. D. Knox*, F.R.G.S., Lieut. (late Royal Navy), 17 Upper Montagu Street, W. (proposed by G. L. Chambers).

*E. T. J. Love*, M.A., Lecturer on Physics at the University, Melbourne, Australia (proposed by R. L. J. Ellery).

*Rev. D. H. Sparling*, B.A., Biddulph Moor Rectory, Congleton (proposed by T. K. Mellor).

## ROYAL METEOROLOGICAL SOCIETY.

THE Annual Meeting of this Society was held on Wednesday evening, January 16, at the Institution of Civil Engineers, Great George Street, S.W., Mr. R. Inwards, F.R.A.S., President, in the Chair.

The Council, in their Report, reviewed the work done by the Society during the past year, and also stated that additional accommodation had been provided to meet the growing needs of the library. Forty-five new Fellows had been elected during the year.

Mr. Inwards, in his Presidential Address, dealt with the subject of "Weather Fallacies," which he treated under the heads of Saints' Day fallacies, Sun and Moon fallacies, and those concerning animals and plants. He also referred to the almanac makers, weather prophets, and impostors who have from time to time furnished the world with fit materials for its credence or its ridicule.

Mr. C. Harding read a paper on "The Gale of December 21st–22nd, 1894, over the British Isles." This storm was one of exceptional severity, especially over the northern portions of England and Ireland and in the south of Scotland. It developed energy very quickly and travelled with great rapidity. The self-recording anemometers show that the greatest violence of the wind occurred at Fleetwood, where the velocity was 107 miles in the hour between 8.30 and 9.30 A.M. on the 22nd; and for four consecutive hours the velocity exceeded 100 miles. This is the greatest force of wind ever recorded in the British Isles, and is 10 miles an hour in excess of the highest wind velocity in the great storm of November 16th–20th, 1893. At Holyhead the wind in squalls attained the hourly velocity of 150 miles between 10 A.M. and noon on the 22nd. The strongest force was mostly from the north-westward. Much destruction was wrought both on sea and land, and there was a heavy loss of life.

---

## BRITISH ASTRONOMICAL ASSOCIATION.

THE second ordinary meeting of the fifth session of the Association was held at University College, Gower Street, on Wednesday, December 19, Mr. E. Walter Maunder, President, in the Chair.

The election of 16 new members was confirmed, and the names of 6 candidates were read and suspended.

*The President* referred briefly to the loss the Association had sustained by the death of their Vice-President, Mr. A. Cowper Ranyard, one of the most devoted and earnest amateur astronomers.

On the motion of Mr. G. J. Newbegin, seconded by Dr. Roberts, a resolution was carried expressing the great regret with which the Meeting had heard of the death of Mr. Ranyard, and its sense of the loss sustained both by the Association and by English astronomy at large.

*Mr. Petrie* read the report of the Mars Section, of which Mr. B. E. Cammell is the director. The report stated that a large number of drawings had come to hand; Mr. Stanley Williams and M. Antoniadi had both been fortunate in seeing projections on the terminator. A large number of canals had been seen by members, Mr. Williams and M. Antoniadi being the most fortunate in this respect, the former having observed more than 50 (many of them double), the latter over 40.

*Mr. G. F. Chambers* read a paper on "The Want of a New General Catalogue of Stars." Mr. Chambers said that not long since he was engaged in compiling a catalogue of all the naked-eye stars down to the 5th magnitude, and two points very forcibly impressed themselves on his mind in the course of this work: (1) the urgent necessity for a new comprehensive general catalogue of stars and (2) that the photometric methods of Harvard and Oxford should be applied with the least possible delay to the southern hemisphere. He suggested the British Association Catalogue should be taken as a model, but its scope enlarged to include all stars of the 7th magnitude.

*Dr. Downing* remarked that the expense of such a catalogue of stars would be very considerable. He had looked into the question lately, and found that the cost of the British Association Catalogue amounted, for computation and printing, to between £1200 and £1400, and an enlarged edition would cost considerably more, probably £2000. He thought it would be better to wait a few years before undertaking such a work. He quite agreed as to the desirability of extending the Harvard and Oxford photometric surveys to the southern hemisphere.

*Mr. Chambers* replied that he had not urged the immediate undertaking of the work. He suggested the beginning of the twentieth century.

*Col. A. Burton-Brown, R.A.*, gave an address on "Suitable Stations in Norway for Viewing the Total Eclipse of the Sun on August 8, 1896," illustrated by a large chart of the whole district under consideration compiled from the best sources. Col. Burton-Brown said he had spent several weeks in visiting all the localities at all suitable for an expedition to occupy, and described in detail the advantages or drawbacks of the various possible stations.

*The President* then announced that the result of the reply-postcards sent out in order to ascertain the most convenient hour for holding the meetings showed a considerable majority in favour of the present hour, 5 o'clock.

The Meeting then adjourned.

## *Note on the Geometrical Optics of the Skew Cassegrain.*

At the last meeting of the Royal Astronomical Society, Dr. Common made the important announcement that he had succeeded in constructing a new form of reflecting telescope, with eminently satisfactory results. The principle of the instrument consists in the oblique reflection of the rays from a distant object, first by a concave and then by a convex mirror, and Dr. Common has found experimentally how the aberrations of the two mirrors may be arranged to counterbalance each other and give good definition at the ultimate focus. I said something on that occasion on the geometrical theory of oblique reflection at curved surfaces, and for convenience give a brief summary of those remarks here, instead of in the reported account of the proceedings at the meeting.

In fig. 1, let $m$ be the mirror; centre of curvature $s$; and consider first a plane section of the rays; if rays diverging from the point $p$ meet at $q$, then $p$ and $q$ are the foci of an ellipse touching the mirror at $m$, and with radius of curvature $ms$. Let $tuvw$ be any straight line in this plane cutting the rays, and now suppose the whole figure to revolve through a small angle about this line as axis; then we shall have an incident pencil of rays passing through the small line $tu$, in the plane of the paper, and through another small line at $p$, perpendicular to the plane of the paper; and falling on a mirror at $m$, whose curvatures are not the same in both directions, the radii being respectively $ms$ in the plane and $mk$ perpendicular to the plane of the paper. The reflected pencil of rays will similarly pass through two small lines (focal lines) at $q$ and $vw$. If the mirror at $m$ is to be a portion of a spherical mirror, the points $s$ and $k$ must coincide; but still the line $tkw$ may have any direction without affecting the generality of the

Fig. 1.

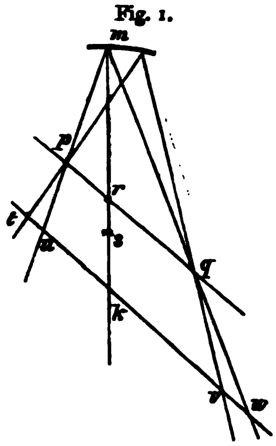
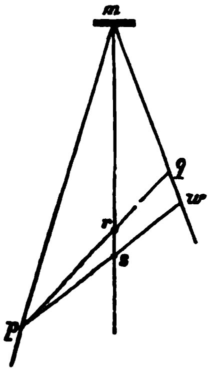


Fig. 2.



propositions; if, further, the incident pencil of rays proceeds from a point and not from two focal lines, then the points *p* and *t* will coincide, the points *q* and *w* of course remaining separated. We shall then have, as in fig. 2, the following construction for the focal lines of the reflected pencil when rays diverging from a point *p* fall at an angle $\phi$ ($= \angle pms$) on a spherical mirror, whose centre of curvature is *s*:—On *ms* take the point *r* such that $mr = ms \cos^2 \phi$*; then *pr* and *ps* cut the reflected ray in *q* and *w*, the positions of the focal lines. The modification when the point *p* is infinitely distant is obvious.

Now suppose we introduce a second mirror convex to the reflected ray, and attempt to reflect a cylindrical pencil to a true focus, *a*.

Let *b* (fig. 3) be the position of the second mirror, and *a* the focus; and let *aq*, *aw* cut the normal to the mirror in *c* and *d*; then, as

Fig. 3.

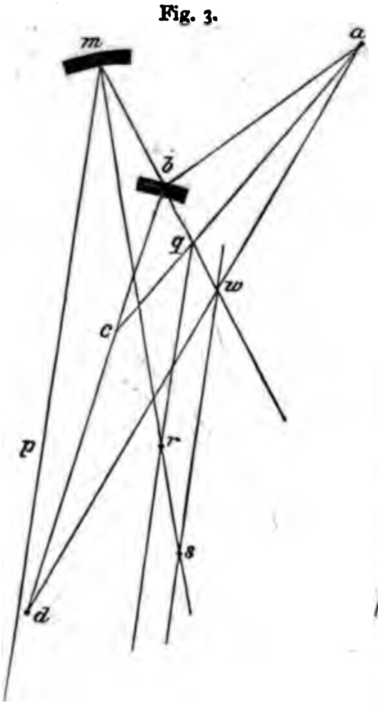
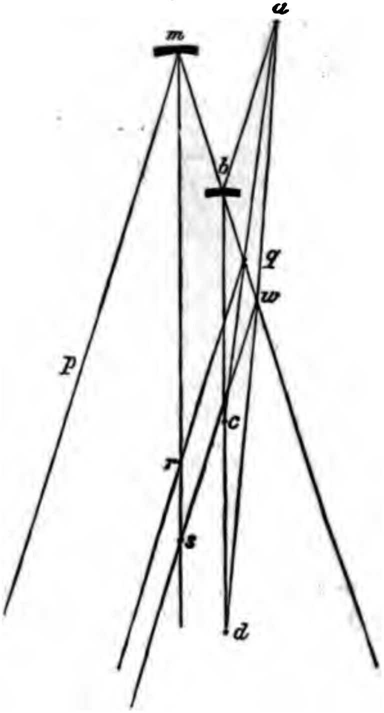


Fig. 4.



before, *d* is the centre of curvature of the mirror *b*, and the point *c* is given by the equation $bc = bd \cos^2 \psi$, where $\psi$ is the angle of incidence on the second mirror. The various cases for different

---

[*] This relation is a property of the ellipse: I do not stop to prove it here.

forms and positions of the two mirrors can thus be easily drawn and classified by this simple geometrical construction. It would take too long to enter fully into them here, but attention may be called to the particular point I mentioned at the meeting of the Society, viz. that the incidence at the second mirror should be considerably larger than at the first, if the ultimate focus *a* is to be near the principal mirror. Dr. Common found this fact experimentally before I reached it theoretically; but it is very easily verified by this construction. It will be seen at a glance that if the line *bcd* be parallel to *mrs* (see fig. 4), that is, if the angles of incidence on the two mirrors are equal, the distance *cd* intercepted by *aq* and *aw* becomes too large to satisfy the condition $bc = bd \cos^2 \psi$. As we rotate the line *bd* (and, accordingly, the line *ba* twice as quickly), the distance *cd* closes up, and it becomes possible to satisfy the above condition without throwing the ultimate focus *a* to a great distance. To see this clearly however, the figures should be drawn to scale; in those given attention has been paid chiefly to diagrammatic clearness, and they are far from correct to scale.

This simple geometrical construction seems to me promising for investigating the whole problem—determining the aberrations and the form of the images. But as yet I have not had sufficient leisure to develop this investigation. H. H. T.

## *On the System $\sigma^2$ Ursæ Majoris* Σ 1306.

$$\left.\begin{array}{l}\text{R.A.}\ldots\ 8^{\text{h}}\ 1^{\text{m}}\ 28^{\text{s}}\\ \text{N.P.D.}\ 22^\circ\ 27'\ 33''\end{array}\right\}\ 1900.$$

It appears to me that the claim of this double star to be included in lists of "Binaries" or even "Suspected Binaries" has always rested on very slender foundation, and now seems quite untenable. At the same time the relative motion of the pair is very interesting, and I hope that, whatever view is taken respecting it, transit-circle observations of both stars will be made.

It is one of the double stars measured by Herschel in 1782 and 1783, but was not again measured until, in 1819, W. Struve included it in his list, and since then it has been fairly well observed with the micrometer.

Looking over Flammarion's notes in his 'Étoiles Doubles,' it is evident that he was much perplexed with the measures; but he finally decided that there was physical connection, and that the plane of the orbit of the companion was nearly in the plane of the line of sight. He says: "B has the same proper motion as A $(-0^{\text{s}}{\cdot}005, +0''{\cdot}11)$, which is nearly perpendicular to the line of relative motion, and consequently does not explain that";...... therefore "orbital motion in plane nearly coincident with visual ray."

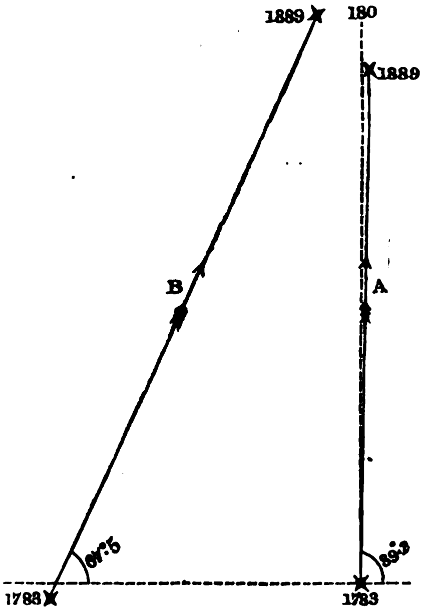
Now I cannot find transit-circle observations of B on which to found any computation of its proper motion, and Flammarion does not quote his authority. If this is merely an inference, then there is no *à priori* reason for physical connection.

When the micrometer observations are plotted down they are as well represented by a straight line as could be hoped for, considering their discordance *inter se*, and back to 1819 better than any curved line. There is, however, a slight doubt as to Herschel's measures. He gives

| | | |
|---|---|---|
| 1782·42 .... | in south preceding quadrant. | |
| 1783·29 .... | 270°± | 7″·93 |
| 1783·68 .... | 283 ·0 | .... |

Leaving these for the present and using only observations since 1819, and assuming a common proper motion, the relative motion is 0″·063 in the direction 103°·5, which, carried back to 1783, gives 272°·0 and 7″·95 for the position at the epoch of Herschel's measures, which are thus fairly represented. No assumption of motion can give so large an angle as 283°·0.

But, as remarked above, we have no reason for assuming that the two stars have the same proper motion; and this leads to regarding the motion (relative) from another point of view.



The Proper Motion of A, according to Auwers, is R.A. +0ˢ·0002 and N.P.D. +0″·064 or 0″·065 in the direction 179°·2.

Correcting the micrometer observations accordingly, the relative motion of the two stars is shown in the diagram, which seems the most reasonable state of things.

This gives P.M. of A $0''\cdot065$ in direction 179·2
„ B $0\ \cdot079$ „ 157·5
or P.M. of A in R.A. $+0^{s}\cdot0002$, N.P.D. $+0''\cdot064$
„ B „ $+0\ \cdot0055$, „ $+0\ \cdot072$

The nearest approach will be $1''\cdot8$, which is rather against the idea of the orbit being "nearly in the plane of the visual ray," and there is absolutely no evidence of deflection from the straight line at either end of the series. T. Lewis.

---

## *Selenographical Notes.*

**Licetus and Cuvier.**—The first of these great enclosures is an anomaly *sui generis*, in a region abounding in exceptional and distorted forms. It has hardly its counterpart in any other portion of the visible surface, and is therefore particularly worthy of examination. Neison describes it as an irregular formation made up of several ring-plains which, once complete, have had the walls which separated them partially destroyed from some cause or other; so that it only appears as a connected whole under very oblique illumination. Under a moderately high Sun, it recalls Phocylides and Hainzel in the 3rd Quadrant, as these also consist of large irregular circumvallations overlapped on the north by smaller, less abnormal, and more massive rings; and, if only observed under such conditions, one would regard Licetus merely as a somewhat more unsymmetrical repetition of these objects. It is seen to the best advantage under a morning Sun and at a phase when the terminator is not far removed from the central meridian. These conditions prevailed, 1895, January 3, $6^h$ to $8^h$, when it was observed with powers of 284 and 340 on my 8½-inch reflector.

Licetus may be described as an oblong formation about 95 miles in extreme length from north to south, and scarcely one-third so wide, except on the north, where it is overlapped by the more regular ring, Licetus *a*. Here it is fully 40 miles from side to side. There is a smaller ring, Licetus *d*, of the normal type at the southern end. The eastern flanks of *a* and *d* are connected by a bright, massive, terraced rampart, nearly lineal, defining the eastern side of the formation, between these rings. On the west the presence of Cuvier has caused a very manifest inflection of the border, which, but for this, would be nearly straight for the greater part of its length. North of this deformation we come to the western wall of Licetus *a*, 10,000 feet in height above the floor, with its well-marked outer slope, running out to a considerable distance beyond the limits of the enclosure, and including on that part of its surface towards Stöfler four or five large irregular depressions and a valley communicating with the southern side of this object.

The central section between the extreme rings *a* and *d* is divided longitudinally by a barrier consisting of a row of bright little hills, which apparently represent the relics of a ruined rampart. Schmidt shows this partition-wall as continuous, which it certainly is not, for I counted on January 3 six distinct elevations ranged side by side, each casting a shadow of different length from that of its neighbour. These two divisions are lettered *b* and *c* in Neison's Map 17, *c* being the more easterly. There are indications of another longitudinal wall parallel to the first and dividing *b* into two nearly equal parts. This also appears to consist of low hillocks and mounds of insignificant altitude. Schmidt shows nothing of this, though he draws a small crater which stands near the southern end of it. Licetus *a*, with its lofty and brilliant western rampart, is a striking object when the morning terminator lies about 6° east of it. Two bright little craters on the eastern side of its dusky interior are at this phase especially conspicuous. With the exception of a low ridge, they appear to be the only features on the floor Licetus *d*, the southern ring, is not visible at this phase, as it is masked by shadows. As sunrise progresses, however, we obtain a glimpse of the loftier portions of its very dark interior, which includes some low mounds. There are nine craters of considerable size on the south-western side of Licetus, close to the wall; two of which are connected with it by unrecorded rill-like valleys, and one, the largest and most southerly, has a minute crater on its western rim. The regularity of outline and the smoothness of the light greyish-blue interior of Cuvier present a great contrast to the abnormal shape and ruggedness of its companion. With all attention no detail could be detected on its floor. Schmidt, however, shows a solitary craterlet on the eastern side. A brilliant crater on the southern rampart, another below the crest on the west, and a group of three large rimmed depressions, which have partially broken the continuity of the northern wall, were very obvious features.

Beaumont House, Shakespeare Road,
Bedford, 1895, Jan. 19.

T. Gwyn Elger.

---

## *Prof. Newcomb's New Planetary Tables.*

In his report on the work of the American Nautical Office during the past year, Prof. S. Newcomb announces the substantial completion of the work, on which he has been engaged for some time, of determining the fundamental constants of astronomy and the elements and masses of the major planets, from Mercury to Saturn. He hopes to have the tables for these planets ready for use shortly, and the similar work for Uranus and Neptune will follow in due course. Prof. Newcomb gives the following interesting summary concerning his work:—

"The present seems an appropriate time to present a general report upon the nature and objects of this work. Its necessity was suggested by the fact that no existing tables of any of the planets, Le Verrier's tables of Mercury and the Earth excepted, were sufficiently exact to satisfy the needs of the astronomy of the present time; and even these two will probably fail for the astronomy of the immediate future. But this is by no means the most serious defect of the existing tables. Even in the best, those of Le Verrier, there is so great a lack of homogeneity in the elements employed, and such a combination of empirical and theoretical results, that it is impossible to decide, without long investigations in each particular case, whether observed deviations from the tables are due merely to defective determinations of the fundamental data, or to unknown causes acting on the motions of the planets.

"The improved determinations of astronomical constants, which have been made from time to time during the last half-century, have not served to diminish the confusion, because they have added to the number of diverse and inconsistent quantities with which the astronomer has to deal. New values to be accepted everywhere as authoritative should be founded on a complete rediscussion of all existing data. This is true, not only of the fundamental constants, but also of the elements of the planetary orbits.

"Since the reduction of the older observations were nearly all made with defective data, or on a system which is now known to be not the best, a necessary part of the work was the complete rediscussion, and in most cases a partial or complete re-reduction of all the good observations of the Sun and planets made since 1750. The actual number of separate meridian observations of the Sun and each of the three planets in question, which have been thus re-reduced or corrected and compared with Le Verrier's tables, are as follows. I add the corresponding number of observations made use of by Le Verrier:—

| Object. | Number of observations in new theory. | Number of observations used by Le Verrier. |
|---|---|---|
| The Sun | 40,176 | 8,911 |
| Mercury | 5,421 | 412 |
| Venus | 12,319 | 551 |
| Mars | 4,114 | 1,019 |
| Total | 62,030 | 10,893 |

"In this list an observation both of right ascension and declination at a single transit is counted as a single observation. Were these two elements counted separately, the total number of observations would be more than 100,000.

"To treat these observations, it was necessary to begin *ab initio* and redetermine the positions of the principal fixed stars used for clock correction. New declinations were also necessary, but they were found in Prof. Boss's exhaustive work on the subject, completed when the present work was beginning. A complete reconstruction from first principles of the mathematical formulæ for the motions of the planets was also necessary, because Le Verrier's investigations made on this subject were made by methods now recognized as not the simplest and best, and it was therefore essential to test his results. So far as the interior planets are concerned, the result has been in substantial accord with that of Le Verrier's researches, the planet Mars excepted. This agreement by two methods resting on entirely different foundations seems to afford satisfactory evidence of the correctness of both. In the case of Jupiter and Saturn, however, the method adopted by Le Verrier signally fails, and Mr. Hill's work must therefore entirely supersede it.

"The scale on which it was necessary to do the work is not adequately indicated by the amount of material used. Ordinarily the determination of the elements of a planet only involves the solution of equations involving 6 or 7 unknown quantities. But in the present theory it was necessary to the satisfactory character of the results that the equations in the case of the three planets observed each should involve 22 or 23 unknown quantities. The total number of equations was as follows:—

| | |
|---|---|
| "From observations of the Sun .......... | 11,676 |
| " " Mercury ...... | 3,929 |
| " " Venus ........ | 4,849 |
| " " Mars ........ | 1,597 |
| Total .... | 22,051 |

"In the case of the Sun the number of unknown quantities could be reduced to 3 or 4 for each equation; but in the case of the 10,375 observations of the planets it was necessary to include the whole 23 unknown quantities.

"The equations had all to be solved by the method of least squares, by which alone could separate values of the required quantities be found.

"Distinguished co-operation has been secured, and utilized in various ways. Worthy of especial mention in this connection is the work of Mr. George W. Hill, formerly an assistant in this office, who resigned in 1892, after having brought the theory and tables of Jupiter and Saturn so nearly to completion that their actual completion would involve no serious difficulty. His official and private works on this and allied subjects, especially on the motion of the Moon, have gained for him at home and abroad the recognition due to one of the first mathematical astronomers of the time.

"In several instances foreign astronomers have made observations and investigations which, to a greater or less extent, were intended to afford available data for the work, though made in the course of regular public duty. First among the distinguished astronomers thus contributing must be mentioned Dr. David Gill, Her Majesty's astronomer at the Cape of Good Hope. The southern latitude of the Cape Observatory and its fine climate would give great value to meridian observations made there. From 1884 to 1890 inclusive, Dr. Gill made a speciality of such observations, and communicated the results in advance of publication. During these years the number of his observations of Mercury was about as great as those made at all the other observatories of the world. Of the greatest value, also, has been the inception by him of a method of determining through actual measurement the parallax of the Sun by heliometer comparisons of minor planets with neighbouring stars. On his motion three campaigns for such observations were undertaken by several observatories of Europe and that of Yale College in the United States. The results of two of these were worked up by Dr. Gill and of the third by Dr. W. L. Elkin, astronomer of the Yale Observatory. All were communicated in advance of publication. They proved to be the most accurate measures on the solar parallax yet made.

"The Astronomer Royal of England has also communicated observations in advance of publication, the last of which proved to be of the greatest importance. They were the meridian observations of Mars in 1892, and their study made evident the defect already alluded to in the theory of the motion of that planet, which might otherwise have escaped detection until much useless work had been done in discussing the observations.

"The courtesy of the directors of the observatories of Paris and of Strassburg, as well as of the computing bureau of the Berlin Observatory, should also be acknowledged in this connection. In the case of Strassburg the reduction of a valuable series of observations of the Sun and interior planets was accelerated, in order that the results might be communicated in time to be utilized. Valuable results of the older Greenwich observations were also received from Dr. Auwers, of Berlin. It hardly needs to be added that the unpublished observations of the Naval Observatory were always placed at my disposal by the superintendent.

"The following works, mentioned in my last annual report as in progress, have been completed, and in most part put in shape for publication:—

(1) The discussion of meridian observations of the Moon, made at Greenwich and Washington about 1862, to determine the solar parallax from the observed value of the Moon's parallactic inequality.

"(2) The discussion of all the contact observations made on the transits of Venus in 1874 and 1882. The separate result of each contact has been completely worked out. I should add that the funds for routine computation on this work were supplied, through Prof. Pickering, by Miss Catherine Bruce, of New York.

"(3) The determination of the mass of Jupiter from observations of Polyhymnia, made from the discovery of the latter in 1854 until 1888, and from the best other sources.

"(4) The computation of the secular variations of the orbits of the four inner planets.

"Several of these and other researches are expected to be published in subsequent volumes of the Astronomical Papers prepared for the American Ephemeris.

"Of Vol. V. of this series, Parts I. and II. have been published during the past year. Part I. contains a development of the perturbative function of planetary motion, which was used especially in computing the secular variations. Part II. contains a computation of certain inequalities of long period in the four inner planets dependent on the second power of the masses.

"Parts II. and IV. are now in press. Part III. consists of a mathematical investigation of the action of the Moon on the planets, which was commenced more than twenty years ago, and which was closely connected with the researches on the motion of the Moon, which I made at the Naval Observatory at that time. Part IV. comprises a computation of the secular changes in the orbits of the four inner planets.

"There are several other points in which the tables of the Ephemeris are in great need of improvement. The most pressing of these is the case of the fixed stars. In recent times there has arisen a greatly increased demand for accurate positions of a much larger number of fixed stars than have heretofore been given in the Ephemeris, owing to the wants of geographical surveyors, as well as of astronomers. The absorption of the office in the work of perfecting the tables of the planets has resulted in the postponement of a much needed improvement of the Ephemeris in this respect. A small appropriation is therefore asked for to enable this want to be supplied.

"New tables of the Moon are also needed by all ephemerides of the world. Those of Hansen, as corrected in this office, are now in universal use. They were published as far back as 1857, and are now found to be defective in several important points.

"S. Newcomb,
"*Superintendent Nautical Almanac.*"

---

## CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

### *Latitude Determinations.*

Gentlemen,—

'Nature,' Sept. 13, 1894, gives a summary of the scientific work of the Brooklyn Meeting of the American Association for the Advancement of Science. In the summary appears the following paragraph:—"Professor Doolittle exhibited a large diagram showing the results of the recent latitude determinations at the Sayre Observatory, of South Bethlehem, Pa. The Chandler theory and these observations differ so much that one can hardly be called an approximation of the other."

In this case the reporter, by telling only half the truth, has given an impression almost the reverse of that intended. The results of observation were compared with Chandler's formula

$$\phi - \phi_0 = -0''\cdot156 \cos (t - T_1') \, 0^\circ\cdot8150 - 0''\cdot153 \cos (\odot - 280^\circ).$$

The agreement in the early part of the series was satisfactory; but soon a separation began, the difference increasing with considerable regularity until it was remarked at the last minimum—near the end of June—the result from the formula could hardly be considered as an approximation to that of observation.

Chandler's latest conclusion was then examined, viz. that the annual movement takes places in a narrow ellipse, the minor unit of which makes a small angle with the meridian of Bethlehem. This was found to represent the epochs of maxima and minima almost perfectly, a result highly satisfactory to all concerned.

Upon the appearance of the above-mentioned number of 'Nature,' a note, intended for publication, was addressed to the Editor containing this statement. This was returned, accompanied by a few words stating that the Editor regretted the incorrect impression conveyed by the brief report of this paper, but that, in view of the very full discussion of the subject by Prof. Foerster in the same number, he thought nothing would be gained by publishing this correction. Possibly this conclusion is the correct one. There are a few, however, who regret that the distinguished editor of 'Nature' did not think differently.

Yours very truly,

South Bethlehem, Pa., 1894, Dec. 20. C. L. DOOLITTLE.

## *A magnificent Meteor.*

GENTLEMEN,—

It is not often that a meteor shines out so conspicuously beyond its fellows as to deserve mention from this side of the world. Such, however, was the case with one seen here on Nov. 24, at $10^h$ $54^m$ Sydney M.T. When first observed by me it was in Cetus, near α Piscium, and brighter than Jupiter. It rapidly increased in brightness and apparent size until the major axis was about 25′ and the minor 15′. It moved comparatively slowly through Aries and Perseus, passing between Algol and ε Persei, about one-third of the distance from the latter star. I was unable to fix the apparent path with accuracy owing to scattered clouds, through which the meteor was plainly visible.

The preceding part was of a blue colour and the following portion a beautiful green, similar to that given by copper. The train was very transient and not more than 1° long. At the greatest outburst the landscape was strongly illuminated, some friends estimating the light equal to that of the full Moon. My own impression made it equal to that of the Moon when eight days old.

It is probable that the meteor followed a longer path than I have described, but so far I am without reports from northern towns. Its visibility to me was approximately four seconds. No detonation was heard.

Yours truly,
WALTER F. GALE.

Paddington, Sydney, N. S. W.,
1894, Nov. 28.

## *Chronology and Eclipses.*

GENTLEMEN,—

In his letter to you dated 1894 Dec. 10, Prof. Stockwell states that "Julius Capitolinus mentions a great eclipse of the Sun which occurred during the first year of the reign of the Younger Gordian;" and goes on to argue that this makes it necessary to carry back the date of his accession to the year preceding that usually adopted by historians (which is A.D. 238), because the only eclipse which can possibly be intended is that of April 12, A.D. 237. For Prof. Stockwell's re-calculation of the circumstances of this eclipse (finding that at Rome the Sun set with 10·6 digits of its diameter obscured) all students of chronology will be grateful to him. But it seems to me that the conclusion he draws from this is, to say the least, not so certain as he supposes. In the first place it may be well to quote the exact words of Julius Capitolinus, which are: "Sed indicium non diu imperaturi Gordiani hoc fuit, quod eclipsis solis facta est, ut nox crederetur, neque sine luminibus accensis quicquam agi posset." To make this description literally true would, it is evident, require not a large partial but an absolutely total eclipse; but let that pass as an unintentional exaggeration from a report given long after the occurrence. The historian does not speak of it as having occurred "in the first year of the reign" of Gordian; but his language undoubtedly implies that the portent which the eclipse was fancied to be took place in the early part of that reign, the whole of which, it will be remembered, amounted to only six years, as that emperor was assassinated in A.D. 244, at the age of nineteen.

The order of events in the year of his accession (a year in which, as Gibbon remarks, "in the space of a few months six princes had been cut off by the sword") seems to have been as follows:—The two elder Gordians proclaimed in February, and slain in March (Gibbon stigmatizes as absurd the notion that they reigned more than a year); Maximin and his son killed in May; Pupienus (or Maximus) and Balbinus appointed emperors by the senate in March and slain in June, on which Gordian III. was raised to the principate. The date accepted by modern historians for this is

A.D. 238, for which Prof. Stockwell proposes to substitute A.D. 237. Now in April (on the 12th of which month the eclipse took place) Maximin still lived and Maximus and Balbinus had been recently nominated emperors by the senate, who had decreed the deposition of Maximin. The elder Gordians, it is true, had been slain, but there was at that time no thought of the younger, a mere boy, becoming emperor. How, then, could an eclipse then occurring have been thought to be a portent of the shortness of his reign? Scaliger refers to it in the fifth book of his 'De Emendatione Temporum.' He quotes the passage in Julius Capitolinus, but thinks the eclipse occurred the year before the accession of Gordian III. "Hæc insignis defectio solis," he writes, "contigit Perpetuo et Corneliano Coss, anno, qui antecessit proxime imperium Gordiani." It is, however, difficult to see how this can have been so; but, as I have before remarked, the matter is hardly mended by taking the eclipse in the same year in which the younger Gordian became emperor, but some months before his elevation. If we accept an eclipse as the real cause of the darkness mentioned by the historian, it seems to me not unlikely that he means the eclipse of August 5, A.D. 240, when he had but just completed two years of his reign, and was about shortly to be involved in the Persian war.

Prof. Stockwell says that Struyck* refers to this eclipse as having occurred soon after the celebration of the Olympic games, and therefore gives its date as that of the first year of the 255th Olympiad, generally supposed to have corresponded with A.D. 241. But it is hardly safe to draw any chronological conclusion from this until some reference has been found to it in an ancient historian.

I have already shown, both in the 'Astronomical Journal' and in the 'Observatory,' that Prof. Stockwell is far from having proved the necessity of removing the accepted dates of the early Roman emperors to one year earlier; and I still believe that Augustus died in the month of August, A.D. 14.

Yours faithfully,

Blackheath, 1895, Jan. 5. W. T. LYNN.

## *Meteors of* 1895 *Jan.* 1.

GENTLEMEN,—

Very few meteors were seen on this date. Mr. Corder, at Bridgwater, counted eight or nine only during a watch extending from about $6^h\ 15^m$ to $10^h\ 45^m$, but the sky was partly cloudy. The writer at Bristol recorded five meteors in observations spreading over more than two hours before $8^h\ 30^m$. The sky was pretty favourable, but the special shower of the epoch disappointed expectation.

---

* I have not succeeded in meeting with the work quoted by Prof. Stockwell All Nicholas Struyck's works known to me are in Dutch.

At $6^h\ 43^m$ a meteor of about the 3rd mag. was seen both at Bridgwater and Bristol, amongst the stars of Draco, and with a slow and much foreshortened path near its radiant in Quadrans.

At $7^h\ 24^m$ a beautiful slow-moving meteor, directed from a shower in the S.E. sky, was also recorded at the two stations named. Mr. Corder, at Bridgwater, estimated it as 1st mag.; it was orange in colour, and left a long train as it sailed down the N.N.W. sky. At Bristol the meteor, though it did not attain a striking brilliancy, was yet a tolerably conspicuous object, and it fell leisurely in an almost vertical path of $33^c$ in the N.W. sky. Its extremely slow, graceful flight enabled the eye to note its fluctuations of light and to record the position and direction of its path with unusual precision. The radiant was in Eridauus, a few degrees E. of $\gamma$, a point from which some fine meteors emanated early in January 1877.

I have computed the following heights &c. from a comparison of the two pairs of observations alluded to:—

| | Quadrantid.<br>Jan. $1^d\ 6^h\ 43^m$. | Eridanid.<br>Jan. $1^d\ 7^h\ 24^m$. |
|---|---|---|
| Height at beginning.. | 58 miles. | 65 miles. |
| Position over ...... | Corwen, N. Wales. | 5 miles N.E. Brecon. |
| Height at end ...... | 47 miles. | 50 miles. |
| Position over ...... | 4 miles E. Montgomery. | 13 miles E.N.E. Aberystwith. |
| Real length of path.. | 30 miles. | 41 miles. |
| Velocity (Bristol obs.) | 13 miles per sec. | 10 miles per sec. |
| Earth-point ........ | Cranborne. Dorset. | Irish Sea. |
| Radiant-point ...... | 233° +56° | 62° −12°. |

Yours faithfully,

Bristol, 1895, Jan. 19. W. F. DENNING.

## *Variable Orange Stars.*

GENTLEMEN,—

It has been suggested that probably all very red stars are variable; but this has not yet been proved. I am able, however, to add another to the list, namely Birmingham 4, in Andromeda. This star is very likely a variable of the 19 Piscium type, though, according to Mr. Espin's work on 'The Red Stars,' observers differ as to whether the spectrum belongs to type III. or IV. Its colour is deep reddish orange.

Another deep reddish-orange star, Birmingham 18, in Pisces, which Mr. Gore has doubtfully suspected of variability, I have only observed twice; but the difference between the two observations seems too decided to be due to error. Its spectrum is stated to be of type IV. in 'The Red Stars.'

Yours truly,

Sunderland, 1895, Jan 24. T. W. BACKHOUSE.

# OBSERVATORIES.

**Natal Observatory.** *C. Nevill.*—From the Annual Report of the Superintendent, Natal Observatory, for the year 1893–94 we learn that the staff is comprised of three ladies. One is styled Astronomical Assistant, another Meteorological Assistant, while the third carries out the auxiliary computations. The observatory is furnished with an 8-inch Grubb refractor, and a 3-inch transit by Troughton and Simms. Owing to the prevalence of cloudy weather it has not been a favourable year for observation. We remarked last year on the resemblance of each successive report, and we still find paragraphs reiterated. One in particular we quote: "A great deal of important work has now accumulated at the Observatory awaiting printing and publishing. It is very desirable that these results should be published as soon as possible as a volume of Natal Observations." Results of observations for latitude by Talcott's method are given, and "the steady and gradual decrease in the value found for the latitude since 1885 is most important."

| | | | ″ |
|---|---|---|---|
| 1884. | Seconds of latitude observed | | 46·94. |
| 1885. | " | " | 47·50. |
| 1886. | " | " | 47·21. |
| 1888. | " | " | 46·63. |
| 1889. | " | " | 46·36. |
| 1890. | " | " | 46·15. |

Mr. Nevill says with respect to this that the observed latitude of the observatory appears to have reached a maximum in the year 1885 and to have steadily decreased since at a nearly uniform rate of 0″·27 per annum; but since all the observations which give these results were made practically during the five months March to July, and are not very uniformly distributed over the period, this variation may be due to systematic errors due to the assumed positions of the stars. The observations, therefore, have been divided into three groups, according to the Right Ascension of the stars observed, and from each of these groups a similar variation appears.

The Report is supplemented by Meteorological Statistics.

---

**Albany.**—The Dudley Observatory, Albany, U.S., established in 1857 under the direction of Dr. B. A. Gould, and which has been for some years under the charge of Prof. Lewis Boss, has been transferred comparatively recently to a new site. It was found that the instruments and buildings required considerable repair, and as the then existing portion had some disadvantages it was considered advisable to make an effort to effect its removal to a better neighbourhood. Contributions were received from private persons amounting to almost 60,000 dollars, of which that generous patroness of the science, Miss Catherine Bruce, supplied

35,000, and the city of Albany made a liberal bargain in providing land for the new observatory, taking the old grounds and buildings in exchange.

The instrumental equipment of the new observatory consists of the Olcott meridian circle, which has been in use in the institution since its foundation, and is described in the introduction to the zone-catalogue contributed by the Dudley Observatory to the Catalogue of the 'Astronomische Gesellschaft,' the observations for which were made with this instrument, and a new equatorial presented to the observatory by the Messrs. Pruyn, sons of a former President of the observatory trustees. The making of this instrument was entrusted to Messrs. Warner and Swasey, the optical parts being made by Mr. J. A. Brashear. The following description of the object-glass is given by Prof. Boss in an article in 'Astronomical Journal,' No. 334, and from which we have also extracted the above information:—"The clear aperture of the telescope is 31 cm., the focal length of the visual combination is 4·57 in., and of the photographic lenses about 4·1 in. The construction of the objectives differs somewhat from the usual type. In both combinations the flint lens is placed in front. The crown lens is common to both. The inner surfaces have a much deeper curve than the outer. Each lens is mounted in its own separate cell. These cells are beautifully fitted and hold the respective lenses of the two combinations in perfect adjustment relative to each other. The advantages of this arrangement are that the objectives may be taken apart and cleaned at any time with ease and safety, and the exchange of combination can be effected within a few minutes and without undue apprehension. When the exchange is made from visual to photographic combination, a section of the tube 24 cm. in length is also removed. The tail-piece, the micrometer, the camera, the cell of the crown lens, and the section of tube previously mentioned are each fastened in place expeditiously and firmly by a device similar to that employed in locking the breech of a Krupp gun, corresponding octants of the screw and nut having been removed, so that a turn of 45° suffices to clamp the piece firmly in place."

This objective has not been yet rigidly tested, but, so far as casual examination goes, the results are perfectly satisfactory. The instrument, provided with a filar micrometer by Warner and Swasey, has been in use since March 1894 for the observation of comets and small planets. Prof. Boss proposes that the fundamental work of the observatory in the future shall be the observation with the transit-circle of stars known to have sensible proper motion, with a view to a discussion of the value of such motion.

---

HARVARD.—Prof. Pickering's Report for the year 1894 relates to the eleven months ending 1894 Sept. 30. The closing date is taken a month earlier than in previous years to be more in uniformity with other departments of the University. The report gives as usual a record of a large amount of work, of which Prof. Pickering selects as noteworthy features the practical trial of the Bruce Photographic Telescope and the work of the Boyden Meteorological Station on the summit of the volcano El Misti at a height of 19,200 ft. With the Bruce telescope 936 photographs have been taken, and the report says "the spectra of the faint stars prove very satisfactory, and stars too faint to be photographed with the other instruments can thus be studied. Bright hydrogen lines have been found in the spectra of S Orionis, S Boötis, W Virginis, and S Libræ, and the spectrum of V Ophiuchi has been shown to be of the fourth type. The length of these spectra is about a quarter of an inch, which is sufficient to show much detail in the spectra of fairly bright stars. To study still fainter spectra a prism of crown-glass and of smaller angle has been ordered. The absorption of the photographic rays is less for this material, and it is expected that much fainter spectra can be photographed, since the dispersion will also be less." Also "a variety of experiments has been made to determine the photographic magnitudes of the brighter stars on a uniform scale. It is now expected that this can be done with the transit-photometer for stars brighter than the third magnitude, and that the scale can be extended to stars from the third to the sixth magnitude by a series of photographs which are being taken with a portrait-lens having an aperture of 2·5 inches. The images are thrown out of focus, and the intensity of the circular discs thus obtained can be accurately measured."

The meteorological station on the Misti is not maintained without considerable trouble. Observers do not live permanently on the mountain, but make occasional visits to the instruments, which are self-recording. The journey itself involves much difficulty, and in September last it appears that some of the instruments had been stolen by Indians. A sentence in the Report implies some doubt whether this station can be maintained.

Speaking of the 13-inch Boyden telescope, which is used for making star-charts with long exposure, Prof. Pickering states in a few words the method adopted to correct practically for refraction and flexure, so that the star-images may have a circular form; he says: "This is mainly due to substituting for a finder two eye-pieces attached to the main telescope. One of them serves to follow a guiding star in the usual way, the other directed to another star shows if the plate needs to be rotated on its own plane."

Work with the 8-inch Draper telescope has been continued, and 1657 photographs have been taken. The number taken in Peru with the 8-inch Bache telescope is 1708. From these eleven new variables have been discovered from the presence of bright hydrogen lines in their spectra, besides three from changes in their photographic images, and five gaseous nebulæ have been discovered from their spectra. Other work done in memory of Henry Draper is an investigation of large parallaxes and proper motions in rather a new way. Photographs of stars are taken on plates in the usual position, with film towards the object-glass, and also with the film reversed, the light passing through the glass of the plate. Six months later, when parallax would have had its greatest effect, similar photographs are taken of the same stars, and the films being placed in contact, the differences in the relative positions of the stars can be readily detected. Several hundred stars have thus been shown to have no parallax exceeding half a second.

Several pages of the Report treat of the work with the Meridian Photometer, and Mr. S. C. Chandler's criticisms thereon.

Observations of variable stars with the East Equatorial have been continued in conjunction with the work of Mr. W. M. Reed, who, during the latter part of the period to which the report refers, has been observing variables with a smaller telescope at Andover, Mass. Photometric observations of the eclipses of Jupiter's satellites have also been made with the Equatorials.

The Report refers to the publication during the year of the catalogue of stars in the zone +50° to +55° for the Astronomische Gesellschaft catalogue, already noticed in these pages (vol. xvii. p. 118), and to the reduction of the observations of the zone −10° to −14°, which is now in hand.

## PUBLICATIONS.

In writing of a certain book in our last number we remarked that no one had yet given a satisfactory popular explanation of the Foucault pendulum experiment for intermediate latitudes. This statement was a little premature, for since making it we have received a book* which gives an excellent explanation, not involving advanced mathematics, of the component rotations of the Earth, and hence of Foucault's pendulum. This is a book called 'A few Chapters in Astronomy,' and gives some ingenious and intelligible explanations of various well-known phenomena which are not treated of fully in the usual textbooks. Many persons have no doubt experienced the difficulty of mentally defining with accuracy the position of a great circle in the sky—*e. g.* one knows that if a great circle be drawn through the centre of the crescent Moon at right angles to the line joining the horns, it should pass through the Sun; but most persons trying this simple experiment will find their mental conception of this great circle deviate from the centre of the solar disc by a considerable amount. The author gives a very plausible explanation of this illusion on the basis that the position of the great circle should be mentally formed by virtue of its inclination to *vertical great circles*, whereas an observer really refers it to vertical lines. The effect of this illusion is followed up in relation to meteor-paths.

---

* 'A few Chapters in Astronomy.' By Claudius Kennedy, M.A. (Taylor and Francis.) 1894. 3*s.* 6*d.*

But to return to the Earth's rotation and its component parts about a vertical line and a north and south meridional line—the author treats of this in some detail, and gives many interesting instances of its effects on terrestrial phenomena. It may not be known to everyone that the rate of motion of stars *in azimuth* at rising is the same, whatever their declination may be, which is an effect of the first-mentioned component. Most persons know that, in theory at least, the right-hand line of a railway in north latitude gets worn more than the left; an effect from similar cause is given in the case of a pigeon flying homeward to a lighthouse, which the following extract may explain:—"The bird is guided solely by his sight of the lighthouse, and the water being perfectly smooth he is without means of knowing that he is always edging sideways to the right of the instantaneous straight line from himself to the lighthouse; he will keep his head always pointed directly towards the lighthouse, and to do this he must be continually turning very slowly towards the left, doubtless without perceiving that he is doing so. The forward velocity of his flight is uniform, and his involuntary sideward motion to the right will go on increasing until the resistance of the perfectly still air to that motion becomes great enough to prevent any further increase therein; the sideward velocity then has reached its final magnitude, and becomes constant like the forward velocity. The bird's visible course, or that relative to the surface of the Earth, will then become *quam prox.* a logarithmic spiral described backwards towards its pole which is at the lighthouse."

The effects of the Earth's rotation on the flight of projectiles and on pendulums are also treated of. We have not space to give extracts from the chapters on these subjects, but they will afford interesting reading to persons who take pleasure in exercising their minds in these matters.

The last half of the book is on a subject which is not often met with in a popular book, if, indeed, this may be called such: it is, in fact, the lunar theory treated in an elementary way; the Moon's variation and parallactic inequality are explained by simple formulæ and diagrams. There is also a chapter on a similar subject—the lunar tide; and a useful subsidiary chapter, containing short descriptions of all the varieties of the "Horizontal" Pendulum, the instrument used to measure this same lunar tidal force. This instrument and its use is not very well known. Mr. Kennedy is to be congratulated on having in this way brought it into the catalogue of instruments understood by the generality of scientific readers. But a similar remark might be applied to the whole book; it is a volume from which the average man may get a great deal of knowledge, and in so doing will find plenty of opportunity for mental gymnastic.

**The Planet Earth: an Astronomical Introduction Geography***. By R. A. Gregory.—This small book of 100 pa has the appearance of a small science primer, and its *raison d'* is that "In class-books of astronomy and geography, facts relati to the Earth's movements and place in the Universe are usua treated in an inadequate manner. Students are informed that Earth is a globe; that it rotates on an axis; revolves round Sun, and is one of a family of planets; but they are not taug these matters scientifically." Whether this be true in part or whole, there cannot be a doubt that the author of the pres little book has arrayed his facts in a very popular and reada manner, and at the same time has induced to a retention of th by a concise and a little more technical synopsis at the end each chapter, which are respectively headed:—I. "The Heav we See," wherein are diagrams and descriptions of the chief c stellations. II. "The Earth as a Spinning Globe," sets forth shape of the Earth; the apparent diurnal motions of the sta dawn and twilight, &c. Here, too, Mr. Gregory has been care to oust out the idea of "circumnavigation" being a proof globularity, and introduces, very happily, the peculiar shape a Cheddar cheese to fix his argument in the minds of beginne III. "Size and Mass of the Earth." IV. "Wandering Star V. "The Order of the Universe," introducing the views of Ptolem Pythagoras, Copernicus; the seasons; precession of equinox Kepler's laws, &c. A book to be honestly recommended for purpose.

## NOTES.

**Comet Notes.**—Encke's Comet was a very brilliant object duri January, and was visible to the naked eye. Viewed with a l power, it appeared to have a sharply defined stellar nucleus. will not be again well placed in the northern hemisphere, but subjoin an ephemeris in the hope that southern observers m secure some observations after perihelion passage. The pla are for Berlin Noon.

| | R.A. | | | S. Decl. | | | R.A. | | | S. D |
|---|---|---|---|---|---|---|---|---|---|---|
| | h | m | s | ° | ′ | | h | m | s | ° |
| Feb. 18.... | 20 | 23 | 25 | 25 | 26 | Mar. 6.... | 21 | 1 | 6 | 24 |
| 22.... | | 32 | 7 | 25 | 31 | 10. .. | | 10 | 14 | 23 |
| 26.... | | 41 | 46 | 25 | 19 | 14.... | | 18 | 54 | 23 |
| Mar. 2.... | | 51 | 34 | 24 | 57 | 18.... | | 27 | 4 | 22 |

Dr. Hind makes an important suggestion with regard to D ning's Comet (1894 *a*). He finds that its orbit makes a very cl approach to that of Brorsen's missing comet, and that the t comets were close to one another in March 1881; he hence conjectures that Brorsen's Comet may at that time have met with a catastrophe causing disintegration, and that a portion of it returned in a slightly different orbit as Denning's Comet.

---

* 'The Planet Earth.' By R. A. Gregory. Messrs. Macmillan & Price 2*s*.

E. Swift's Comet was still visible on December 27, being seen on that day by Dr. Cerulli at Teramo. He described it as circular, about 1′ in diameter. It was observed at Denver and Northfield on Dec. 31, but was exceedingly faint. Moonlight prevented further observations.

Dr. Hind has published the following elliptical elements of Comets 1847 V. (Brorsen) and 1888 V. (Barnard):—

| | | | |
|---|---|---|---|
| T= | 1847 Sept. 9·46190 G.M.T. | | 1888 Sept. 12·81248 G.M.T. |
| $\pi$ .... | 79° 3′ 55″·2 | 1847·0. | 68° 24′ 17″·1 |
| ☊ .... | 309 53 34 ·6 | | 137 33 5 ·5 |
| $i$ .... | 19 10 16 ·0 | | 56 23 28 ·6 |
| $\phi$ .... | 77 43 0 ·5 | | 83 19 55 ·87 |
| log $a$ .. | 1·3295204 | | 2·3542167 |
| log $p$ .. | 9·9852342 | | 0·4839770 |
| Period. | 98·69 years. | | 3398·8 years. |

A. C. D. C.

---

Minor Planet Notes.—A new planet, BN, was found by Charlois on 1894 Dec. 28. A planet was discovered on a photograph taken by Dr. Roberts on 1894 Apr. 9, and this has been lettered BO.

A. C. D. C.

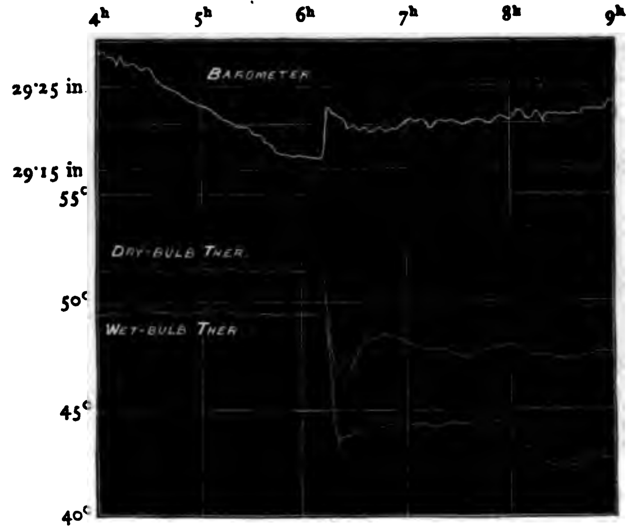
---

Transit of Mercury of 1894 Nov. 10.—Several accounts of observations of the recent Transit of Mercury have been published. Mr. Tebbutt, of Windsor, New South Wales, gives an account, in 'Ast. Nach.' 3270, of successful observation of the time of egress. He says: "Although a very small white spot was occasionally seen in the centre of its disc there was no trace of a halo or of a satellite." The American observations are given in various numbers of the 'Astronomical Journal.' Time of ingress was observed by Prof. Young at Halsted, Prof. Reed, and by Prof. Hagen at Georgetown; of egress by several observers at Ann Arbor observatory and at Yale; Prof. E. C. Pickering contributes observations of time of egress made by five Harvard observers to 'Ast. Nach.' 3269. The times of both ingress and egress were observed by Rev. G. M. Searle at Washington, Dr. C. L. Poor at the Johns Hopkins Observatory, Baltimore, and by Prof. Campbell at Lick. Profs. Young, Reed, and Campbell agree in having seen the pear-shape of the satellite before contact at ingress; and Prof. Todd, of Amherst, states, as do Profs. Reed and Campbell, that they could see no satellite nor accompanying white spot. A meridian transit observation of Mercury while on the Sun's disc was made by R. H. Tucker at Lick.

---

In amplification of our brief account of the great gale of December 22 last ('Observatory,' Jan. 1895, p. 67) we are enabled by the courtesy of the Astronomer Royal to give here a copy of the simultaneous changes in the barometer and dry-bulb and wet-bulb thermometers, as registered at the Royal Observatory during the remarkable squall which occurred at $6^h$ $10^m$ on the morning of that day at the inception of the gale.

Dec. 22 (Civil Time).



Briefly summarized, the changes were as follows:—the barometer, which had previously been falling steadily, shows a sharp increase of 0·06 in.; the thermometer fell simultaneously 5° (rather more in the wet-bulb), a slight recovery following. Full particulars relating to the passage of this gale across the United Kingdom have been embodied in a paper by Mr. C. Harding, of the Meteorological Office, referred to in the account of the Meeting of the Royal Meteorological Society on p. 79. Movements of almost precisely similar character to those shown above were recorded on the morning of Jan. 23 in the violent squall at $9^h$ $48^m$ preceding the notable snow- and thunder-storm.

---

From the 'Bulletin mensuel de la Société Astronomique de France,' 1895 January, we learn that M. Flammarion is to be editor-in-chief of this publication, and that the reason for giving up 'L'Astronomie' was in great measure due to overwork. The Society now numbers 700 members. Here is what M. Flammarion writes:—"Cette Association Scientifique et la 'Revue

d'Astronomie' se touchant de très pres, faisaient presque double emploi, d'autant plus que je communique à la Société toutes les observations et tous les documents que je reçois. Il y avait là un surcroît de travail qui peut être allégé de moitié. Les forces ont une limite, surtout lorsqu'on a de lourdes charges sur les épaules."

Greenwich was not the only observatory which suffered by the gale of Dec. 22. We read that at Mr. Espin's observatory, Tow Law, Durham, the 20-ft. dome, made of a strong framework of wood covered with zinc, was lifted bodily off and carried by the wind through a horizontal distance of 42 ft., and over a wall 5 ft. high, which is distant 28 ft. from the original place of the dome. Mr. Espin thinks that this occurred at an early hour of the morning.

With great regret we have to record the death of Dr. Arthur Cayley, Sadlerian Professor of Pure Mathematics in the University of Cambridge, and some time President of the Royal Astronomical Society. We hope to give more information about the deceased gentleman in our next number.

We also hear of the death of Sir James Cockle, F.R.S., a well-known member of the Royal Astronomical Society.

It is announced that Dr. Theodore Bredichin is compelled by advancing years and the exigencies of health, which is not suited by the climate of Poulkova, to retire from the Directorship of the Russian National Observatory.

Prof. E. J. Love, of Melbourne University, has been making relative determinations of gravity in the Record-room at Greenwich with half-second pendulum.

Dr. J. Dreyer's "Micrometric Observations of Nebulæ made at the Armagh Observatory," and which were presented to the Royal Irish Academy, 1893 Dec. 11, are now sent out as a separate pamphlet.

Dr. T. J. See has a very interesting paper in the January number of 'Popular Astronomy,' on "Sirius in Ancient Times," which we propose reprinting in a future number for our readers.

## FROM AN OXFORD NOTE-BOOK.

On Friday, February 8, after the Annual Meeting of the Royal Astronomical Society, there will be a dinner at the Criterion Restaurant in Piccadilly, open to all Fellows of the Society and their friends (price 7*s.* 6*d.* each, not including wines). Some years ago a dinner of the Society after the Annual Meeting was held with some regularity. This excellent custom has lately fallen into desuetude. The R. A. S. Club, who intermit their regular dinner on the occasion of the Annual Meeting, have, however, attempted to revive the custom in a modified form, and cordially invite Fellows and their friends to join them under the above conditions. Intending diners are requested kindly to send their names either to the Secretary of the Society, or to Dr. Common, 63 Eaton Rise, Ealing, some few days beforehand if possible; though those who are not able to come to an early decision will of course be welcomed, in the interests of a large and successful gathering.

WITH reference to the recent discussion on the periodicity of sun-spots, and more especially to Mr. Lynn's theory that this periodicity is due to the visits of a meteor-swarm, which is possibly a recent addition to our solar system, attention might be called to the list of sun-spots observed in past ages collected by Mr. Hirayama from the Chinese annals, and given in vol. xii. of this magazine, page 218. Phenomena which may with great probability be identified with naked-eye sun-spots are here recorded as far back as the year 188 of our era. I was at some pains to test the series of records for periodicity, although a table of naked-eye spots does not of course lend itself readily to such a purpose; and the results given in a note appended to the paper cited seem to show that it is not impossible that the 11-year period is ancient in origin. The word "ancient" must here of course be read in the light of the context. Two thousand years is not a large period in the history of the solar system, but the birth of the meteor-stream in our system has been supposed by some to have occurred only a century ago.

MR. HIRAYAMA's name reminds me of the beautiful pictures of diffraction phenomena obtained photographically which he has recently published in collaboration with Dr. Scheiner, of Potsdam. By placing small diaphragms before the object-glass of a telescope, the experimenters obtained a telescope with an enormous ratio of focal length to aperture, giving diffraction rings at the focus of very large sizes, which they readily photographed. The results for semicircular apertures are of special importance as bearing on heliometer measures.

LIBRARIANS and all who use libraries must have often felt the necessity for reform in the irregular sizes of publications. It would seem well-nigh hopeless to secure uniformity in the sizes of scientific papers, although this idea has been discussed by more than one of our more influential learned societies. But it is not unreasonable to hope that the publications of the same observatory or institution should preserve a uniformity in size, though such is not the case at present. The publications of an American observatory not yet a quarter of a century old are of three or four different sizes. With some cutting of the pages they can perhaps be bound so as to present uniformity, but such cutting is to be deprecated. New methods or objects of research doubtless necessitate new tables, which fall most naturally into a size different from their predecessors, and if care is not taken the inevitable result is change in size and shape of the publications; but it is always possible with a little trouble to arrange such tables so that they may fit the page already in use, and in the older observatories, such as Greenwich, a great deal of labour is bestowed to attain this end rather than introduce a want of uniformity into the series of volumes. If this trouble were taken more generally the arrangement of libraries would be much facilitated.

---

ANOTHER instance in which uniformity is especially desirable is that of cometary notation. The small letters *a*, *b*, *c*, &c. are now generally understood to refer to the order of discovery, and the Roman numerals I, II, III, &c. to the date of perihelion passage; but it has not been decided whether to write "Comet 1894 *a*" or "Comet *a* 1894," whether to write "Brooks's Comet" or "Comet Brooks," &c. The matter only becomes important in indexing publications; but the need for uniformity is there so pressing that some final convention would be of the greatest value. Would the following convention meet the case?—the order to be uniformly, letter, year, Roman numerals, discoverer; with further the convention that several or all of these designations should be recorded as often as possible? The full name of a comet would then run as follows:—Comet *a* 1892 I (Swift); and if any part of this name is quoted instead of the whole the items should be placed in this order.

---

IN explaining the other day the convention that an *error* and a *correction* are of opposite signs, I was met by an unexpected difficulty. In exhibiting residuals it is the common practice to make the above distinction between "error of tables" and "correction to tables": indeed, it is understating the case to call it a convention, or the common practice: there is a fundamental reason for it. But the difficulty raised was that we speak of a positive *error* of collimation when we mean that the *correction to be applied* is positive; and error and correction are thus exhibited as of the same sign. Similarly, of course, with level and azimuth. It does not seem advisable to change in any way a universal practice; but it is perhaps worth while to draw attention to the anomaly when explaining matters to the uninitiated.

---

A GOOD book of reference is of such value in saving time and trouble that an occasional acknowledgment is but a poor return for benefits conferred. I should therefore like to express, from considerable experience, my indebtedness to Harkness's 'Solar Parallax and Related Constants' as a useful compendium in time of need. There are processes adopted in the work about the validity of which I confess I have some doubts; but questions affecting the uncertain digits in an astronomical constant are from one point of view of little moment; almost any scrupulously fair process will give much the same result. The great point is to have in a tabular form the different individual results instead of having to hunt up each in turn; and for this we certainly owe Prof. Harkness our best thanks.

SOME recent correspondence in the 'Times' on the subject of "Record Whist Hands" is instructive with reference to picturesque illustrations of large figures. A writer, signing himself "A Mathematician," endeavoured to express the enormous chances against the occurrence at any particular deal of a "record whist hand" (namely, a hand in which each player holds the whole of a suit) by the following estimate:—"Take all the national debts of all countries in the world, and all the debentures and shares &c. of all companies, multiply this by a billion, and then bet the sum so estimated against a farthing." Those who are accustomed to deal with figures would not find it difficult to supplement this example by calculating what are the odds against such a hand having been dealt since whist was ever played at all. It may be considered doubtful whether more than a billion hands at whist have ever been dealt, and consequently the odds against a "record whist hand" *ever* having legitimately occurred would be represented by at least the above huge ratio, omitting merely the multiplication by one billion. It would seem, however, that this step is by no means an easy one for the average reader to make, for two days afterwards another writer is at some pains to ask the question, What are the odds against such a hand occurring within five years? pointing out that many *millions* of hands must be dealt within that time, and apparently expecting seriously to diminish the odds thereby. Lecturers on astronomy may perhaps therefore take a hint that some of their illustrations of large astronomical figures do not go very far with the average listener.

As a matter of fact, the average listener, or the average reader, is but little accustomed to use figures accurately at all, if we may judge by the writings of the average journalist who writes for him. For instance, the other day a description appeared in one of our leading weeklies of the remarkable diving performances of a young lady from a height of 70 feet into a net; and not content with generalities, the writer gave the following numerical estimate of the undertaking: "She starts on her descent with a weight of ten stone, and with each yard her weight doubles." He would perhaps be surprised to learn that under these circumstances the net would receive a weight of about 100,000,000 stone.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 225. MARCH. 1895.

## ANNIVERSARY MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, February 8, 1895.

Mr. E. B. Knobel, *Vice-President*, in the Chair.

*Secretaries*: Prof. H. H. Turner, M.A., B.Sc., and E. W. Maunder.

The Minutes of the last Anniversary Meeting were read and confirmed.

The report of the Auditors of the accounts for the past year was read by Mr. J. E. Drower, and was to the effect that, having examined the Treasurer's account and the account of the assets and property of the Society, they certified them to be correct. The cash in hand on the 31st of December, 1894, was £443 5*s.* 10*d.*

*Prof. Turner* read the list of the names of Fellows of the Society who had died during the past year, with extracts from some of the obituary notices. The following are the names in the list:— J. W. F. Allnutt, S. P. Chapman, Charles Carpmael, Prof. Arthur Cayley, Edwin Clark, Sir James Cockle, A. S. Harrison, B. J. Hopkins, Richard Johnson, George Knott, James Leigh, John Morgan, William Peters, A. Cowper Ranyard, Rev. Henry Roe, John Spencer, William Tomlinson, George Wall.

*The President* (who now occupied the Chair). The Council have passed a resolution desiring to put on record their sense of the great loss the Society has sustained by the death of Professor Cayley, and I think the Meeting would wish to join in that resolution. I will simply put it from the chair that at their Anniversary Meeting the Fellows of the Royal Astronomical Society desired to place on record their high appreciation of the services rendered by Prof. Cayley to mathematical astronomy, and to show their sincere sympathy with his family in their recent bereavement.

The resolution was unanimously agreed to.

*Prof. Turner* read extracts from the obituary notices of deceased Fellows.

*Mr. Maunder* read extracts from the reports of the work of observatories during the past year.

*Prof. Turner* read some notes on the progress of astronomy during the year 1894; the subjects referred to were:—the discovery of small Planets and Comets; the investigation of the Variation of Latitude; Progress of Meteoric Astronomy in 1894; the recent Opposition of Mars; the effective Temperature of the Sun; Solar Spectroscopy; Solar Activity in 1894; Lockyer's Photographic Spectra of some of the Brighter Stars; the Spectra of $\beta$ Lyræ and $\delta$ Cephei; the Satellite of Neptune; Double Stars; Nova Normæ; Jupiter; the Radcliffe Catalogue; New Observatories; Spectroscopic Observations of Nebulæ; the Transit of Mercury; the Potsdam Photometry; the Astrographic Chart.

*The President.* Gentlemen,—The Council have awarded the Gold Medal of the Society to Dr. Isaac Roberts for his work in photographing star-clusters and nebulæ. (Applause.)

After stating the grounds for this award in an address which treated of the progress of photography, especially as applied to astronomy, and of Dr. Roberts' work in connection with this branch of the science, Capt. Abney handed the medal to the Secretary to be conveyed to Dr. Roberts, who was unable to be present.

*Mr. Waters.* Mr. President,—I am sure I speak on behalf of the Meeting when I say that we have listened to your admirable address, in which you have given us such an excellent account of Dr. Roberts' work, with the greatest possible interest. Dr. Roberts is fortunate in having as an exponent of his work one who has had so long an experience in photography; and we also are fortunate in having listened to your address to-day. Dr. Roberts' work is so well known to the Society and so well appreciated, that we feel no justification can be required of the award of the medal by the Council; but at the same time this general feeling on the part of the Society and the scientific world does not in any way diminish the pleasure with which we have listened to your address on the subject. I now move "That the report now read be received and adopted, and that it be printed and circulated in the usual manner, together with the President's Address and the report of the Auditors."

*Rev. A. L. Cortie* seconded the motion, which was unanimously agreed to.

Mr. Woodd-Smith and Capt. E. H. Hills were appointed scrutineers of the ballot for President and Officers of the Society for the ensuing year, which was then proceeded with, and the following gentlemen were elected to serve:—

*President*: Dr. A. A. Common. *Vice-Presidents*: Capt. W. de W. Abney, W. H. M. Christie, Dr. J. W. L. Glaisher, E. J. Stone. *Treasurer*: E. B. Knobel. *Secretaries*: E. W. Maunder, Prof. H. H. Turner. *Foreign Secretary*: Dr. William Huggins. *Council*: Sir R. S. Ball, Prof. G. H. Darwin, Dr. A. M. W. Downing, Richard Inwards, Frank McClean, W. H. Maw, H. F. Newall, Capt.

William Noble, Dr. Isaac Roberts, G. M. Seabroke, Rev. Walter Sidgreaves, E. J. Spitta.

*Rev. F. Howlett.* I have the honour to move: "That the thanks of the Meeting be given to the President, Vice-Presidents, and other members of the Council now retired, for their admirable services in promoting the objects of the Royal Astronomical Society."

*Rev. S. Kinns.* I have very great pleasure indeed in seconding the motion. I am sure all of us who heard this afternoon the excellent and most interesting address from the late President must feel we have lost something, but have also gained something, so that we are in the good position of having a balance; and I think we owe very many thanks to those who have been in office during the past year. I think especially we have to thank the Secretaries for the admirable report, written altogether in a way to interest every one of us.

The motion was unanimously agreed to.

On the motion of Mr. Dyson, seconded by Capt. Harrison, a vote of thanks was accorded to the Auditors of the accounts and the Scrutineers of the ballot.

The following gentlemen were elected Fellows of the Society:—

*Edwin Bare*, Ruthven Villa, Hainault Road, Leytonstone; *Vincent Joseph Bouton*, B.Sc., 9 Lansdown Terrace, Hampton Wick; *Comte A. de la Baume Pluvinel*, 7 Rue de la Baume, Paris; *Henri Deslandres*, D. ès Sc., l'Observatoire, Paris; *George Darley Lardner*, 6 Prince's Road, South Wimbledon; *C. W. D. Perrins*, Davenham Bank, Malvern; *Charles A. Post*, 21 Washington Square N., New York City; *Charles Roberts*, 6 Bramerton Street, King's Road, Chelsea, S.W.

---

## BRITISH ASTRONOMICAL ASSOCIATION.

The third ordinary meeting of the Association was held at University College, Gower Street, on Wednesday, January 30, Mr. E. Walter Maunder, President, in the Chair. Six new members were elected, and the names of nine candidates for membership were read and suspended.

*The President* announced that Mr. Henry McEwen, a member of the newly formed Glasgow branch of the Association, had been appointed Director of the Venus and Mercury Section. Mr. McEwen's circular to members of the Section was then read by Mr. Petrie.

*The President* pointed out that the work of the new Section would be both a difficult and an interesting one, but that much might be done by the patient and persevering co-operation of a number of organized observers. The rotation-period of Venus, which was at present to some extent an open question, might be finally settled.

*Mr. G. M. Seabroke* urged the desirability of observers getting other observers to check their work as much as possible. The markings on Venus were so exceedingly faint that the imagination was apt to come into play.

*Miss Everett* read a paper on "The Zodiacal Light," by Mr. S. M. B. Gemmill, in which he urged that more attention should be given to this rather neglected branch of observation. In the discussion which followed it was pointed out that this was a branch of observation that members not fortunate enough to possess telescopes might take up.

An interim report of the Jupiter Section, on the "Red Spot and the Region Near," by the Rev. W. R. Waugh, the Director, was then read, in which it was pointed out that the region was in a state of great activity, and would probably repay careful observation.

*Mr. W. Hale White*, in a "Note on Sun-spots," described a series of observations he had made to test the truth of Wilson's theory. He concluded that the invariable appearance of spots when foreshortened near the limb was inconsistent with the idea that they were simple cavities with sloping sides.

*Rev. A. L. Cortie* said that he had closely observed many hundreds of sun-spots, and his impression was that Wilson's theory was in the main correct. He pointed out that spots during the period of formation or breaking up were very irregular in shape, and could not fairly be used as tests. If observed during the middle or quiet period of their development, when the umbra was central, the evidence that they were cavities was very strong. He believed that sun-spots were not merely isolated phenomena occurring in some disturbed solar region, but that they were intimately connected with one another, and were but the surface manifestations of centres of forces which existed below the solar surface and moved according to, as yet, undiscovered laws.

*Mr. E. Holmes* remarked that, as the solar disc was magnified by irradiation, a spot close to the edge must necessarily appear as a depression, even if no depression actually existed. He pointed out also that spots sometimes appeared considerably north and south of the equator, but that drawings made in these positions never appeared to him to show foreshortening north or south, as they should do if Wilson's theory was correct.

*Mr. Seabroke* said that he had been about to make a similar remark to that of Mr. Holmes on the effect of irradiation. He thought that the Wilsonian theory could only be proved by the concurrent evidence of a large number of careful observations.

*The President* pointed out that whatever might be said as to the Wilsonian theory as a whole, there could be no doubt whatever that, as it was put forward in most textbooks, it was given in a very absurd form. The ordinary illustrative diagrams usually gave a depth of, say, 20,000 or 30,000 miles; and he thought that such a depth was absolutely inconceivable. If they assumed a depth of 100, 200, or 300 miles, it was sufficiently deep to look down upon, but was very shallow relatively to the area of many of the spots, which might be from 10,000 to 20,000 miles in diameter, and foreshortening of the penumbra would in such a case only be detected when close to the limb. He was disposed, as the result of his own observation, to believe that the spots were shallow depressions. Father Cortie had raised some very interesting points which had often engaged his own attention, but he was afraid the problems involved had hardly yet been touched.

Papers on "Encke's Comet," by Mr. S. H. R. Salmon, and "The Nature of the Canals on Mars," by Mr. J. Orr, were also read, and in the course of the evening a number of lantern-slides, illustrative of the papers read, were thrown upon the screen.

---

## ROYAL METEOROLOGICAL SOCIETY.

The usual monthly meeting of this Society was held on Wednesday evening, February 20th, at the Institution of Civil Engineers, 25 Great George Street, S.W., Mr. R. Inwards, F.R.A.S., President, in the Chair.

Mr. W. Marriott gave an account of the thunderstorm and squall which burst over London so suddenly on the morning of January 23rd. It appears that this storm passed across England in a south-south-easterly direction, at the rate of about 47 miles an hour, being over Northumberland at 4 A.M., and reaching the English Channel by 11 A.M. Thunder was first heard in the vicinity of Leeds, and accompanied the storm in its progress across the country. One of the most remarkable features of the storm was the sudden increase in the force of the wind; for in London it rose almost at one bound from nearly a calm to a velocity of 36 miles an hour. This sudden increase of wind caused considerable damage, and at Bramley, near Guildford, twenty-eight trees were blown down along a track 1860 yards in length.

Mr. E. Mawley presented his Report on the Phenological Observations for 1894. Between the third week in March and the third week in May plants, generally, came into blossom in advance of their usual time, and towards the end of April the dates of first flowering differed but little from those recorded at the same period in the very forward spring of 1893. The cuckoo made its appearance even earlier than in the previous year. The year 1894 was a very productive one, and both the hay and corn crops proved unusually heavy, but much of the latter was harvested under very trying conditions as regards weather. The frosts of May 21st and 22nd entirely destroyed the previous prospect of a glorious fruit-season. Indeed the only really good crop was that of pears, which were singularly abundant throughout nearly the whole of England.

Mr. A. B. MacDowall read a paper on some gradual weather changes in certain months at Greenwich and Geneva.

---

## *Arthur Cayley.*

By the death of Professor Cayley the world has lost its greatest mathematician. Most of his work is of such a kind that only those who have followed him into the goodly states and kingdoms which he discovered can rightly estimate his greatness, but all who knew him can tell of his kindness and goodness. The strength of his mind and character were so clearly written in his face that he inspired even strangers with a feeling of reverence.

Arthur Cayley was born at Richmond on August 16, 1821. He was for three years at a private school at Blackheath. After three years at King's College School, he went up to Trinity College, Cambridge, at the early age of 17. Mr. Munro, the great Lucretian Scholar, and Lord Denman belonged to the same year, while Prof. Sylvester, whose name has since become so closely associated with Cayley's, entered the University several years before him. He was Senior Wrangler and First Smith's Prizeman in 1842. Cayley was elected a Fellow of Trinity the same year, and was for three years an Assistant Tutor of the College. As he could not retain his Fellowship for more than seven years from the date of his Master's degree, owing to his not taking Holy Orders, he decided to follow the legal profession. He was called to the Bar in 1849, and some of his most important mathematical papers were written in Lincoln's Inn. He returned to Cambridge in 1863 as Sadlerian Professor of Pure Mathematics, giving up, in the interests of his Science, a good practice as a conveyancer and the prospect of eminence in his profession for the very modest income at that time attached to the Professorship. Here he stayed till his death, lecturing during two terms of the year on whatever was at the time the subject of his research. His prodigious industry is attested by the large number of memoirs written by him, which amount to more than 800. These are being republished by the Cambridge University Press. Seven large volumes have already been published under Cayley's own editorship, and there will probably be at least four more volumes.

For several years Cayley edited the publications of the Royal Astronomical Society. He was President of the Society in 1872 and 1873, and gave the Address on the occasion of the presentation of the Society's Medal to Prof. Newcomb.

In 1882 he gave a course of lectures at the Johns Hopkins University, where his friend Sylvester was at that time Professor.

In 1883 he presided at the British Association Meeting at Southport, and there are several stories current of the difficulties some of the Associates had in following the President's Address.

Professor Cayley received honours and degrees from most of the learned Societies of the world. The Copley and Royal Medals were awarded to him by the Royal Society, and the De Morgan Medal by the London Mathematical Society.

Nearly every branch of Pure Mathematics has been furthered by Cayley's work. His discovery of the Theory of Invariants was the foundation of Modern Higher Algebra, and the creation of this vast subject was due mainly to Cayley and Sylvester. We have it on the authority of Dr. Glaisher that "as an algebraist he has never been surpassed." The connected subject of Analytical Geometry has also been largely extended by Cayley, as reference to Dr. Salmon's works abundantly testifies. The most important English contribution to Elliptic Functions was written by him when he resided in Lincoln's Inn. He has also written largely on the Theory of Numbers, on Integral Calculus, and on Attractions. He drew up for the British Association a very full report "On the Progress of Theoretical Dynamics." Dr. Glaisher tells us that he was an admirable referee for papers submitted to scientific societies for publication, on account of his power of entering at once into the works of others, so that, by merely dipping into a long and complicated paper, he could appreciate its significance, and often give new proofs of the theorems contained in it, or carry the investigation further.

In Astronomy we find 40 or 50 papers by him either in the 'Memoirs' or in the 'Monthly Notices' of the Royal Astronomical Society. These are on such varied subjects as Planetary and Lunar Theory, the Determination of Orbits from three observations, Precession and Nutation, and Solar Eclipses. When Adams, taking into account the change in the eccentricity of the Earth's orbit, obtained a value for the secular acceleration of the Moon's mean motion differing from Laplace's, Cayley entered into the discussion which followed, contributing a paper on the subject to the 'Monthly Notices' in 1861, which confirmed Adams' result.

Cayley was always ready to place his legal skill and knowledge at the service of his college and university. He assisted to draw up the present statutes of Trinity College; he also framed the regulations for the Isaac Newton Studentship at Cambridge. He was interested in the higher education of women, and was for some years Chairman of the Council of Newnham College.

His health had been steadily declining for several years past. He had a severe attack of illness on January 8, from which he seemed to be recovering, when, on January 21, he began to grow rapidly weaker and died on January 26. He was buried on February 1 at Cambridge, where a large number of his friends and associates assembled to do honour to his memory.

F. W. Dyson.

[We propose to publish a portrait of the late Professor in our next number.—Eds.]

## *The Group* Σ 1516.

As a wide pair (AB) this has been known about 100 years. When observed by Lalande, B was the preceding star and in the catalogue "Lalande (F)" is numbered 1830, while A is 1831. At the present time A precedes by some 17″.

In 1858 Otto Struve found a 12th mag., the star C, whose position with respect to A has up to now only changed very little.

This star has been only rarely observed, and it is with the view of transferring the attention of observers from AB to AC that the present note is written.

The following mean positions will enable anyone to see the relative motions of the three stars:—

| | AB. | | | AC. | |
|---|---|---|---|---|---|
| | Pos.-angle. | Dist. | | Pos.-angle. | Dist. |
| 1824·1.. | 296°·2 | 13″·35 | 1860·0.. | 295° | 8″·13 |
| 1835·0.. | 301 ·4 | 8 ·69 | 1865·4.. | 298 | 7 ·70 |
| 1846·4.. | 317 ·5 | 4 ·45 | 1869·8.. | 295 | 7 ·72 |
| 1857·3.. | 37 ·0 | 2 ·74 | 1874·3.. | 297 | 7 ·53 |
| 1868·5.. | 76 ·8 | 6 ·15 | 1891·3.. | 299 | 7 ·58 |
| 1879·4.. | 92 ·0 | 10 ·50 | | | |
| 1891·3.. | 96 ·8 | 15 ·37 | | | |

From these it is seen that the relative positions of A and C have varied but little, while the motion of B (apparent) is 0″·424 in the direction 105°·0. This apparent motion of B is really the motion of A, for we learn from the meridian observation of A that its P.M. is 0″·42 in the opposite direction. It is evident that C partakes of this motion, and AC we may conclude to be a physical pair having a common P.M. of 0″·424 in the direction 285°·0, and that B has no connection with the system. Flammarion gives the apparent motion of B as 0″·404 in the direction 94°. This possibly is a clerical error of 10°. From the "Oxford Astronomical Observations" I learn that the P.M. is 0″·42 and parallax 0″·146 (the mean of four determinations).

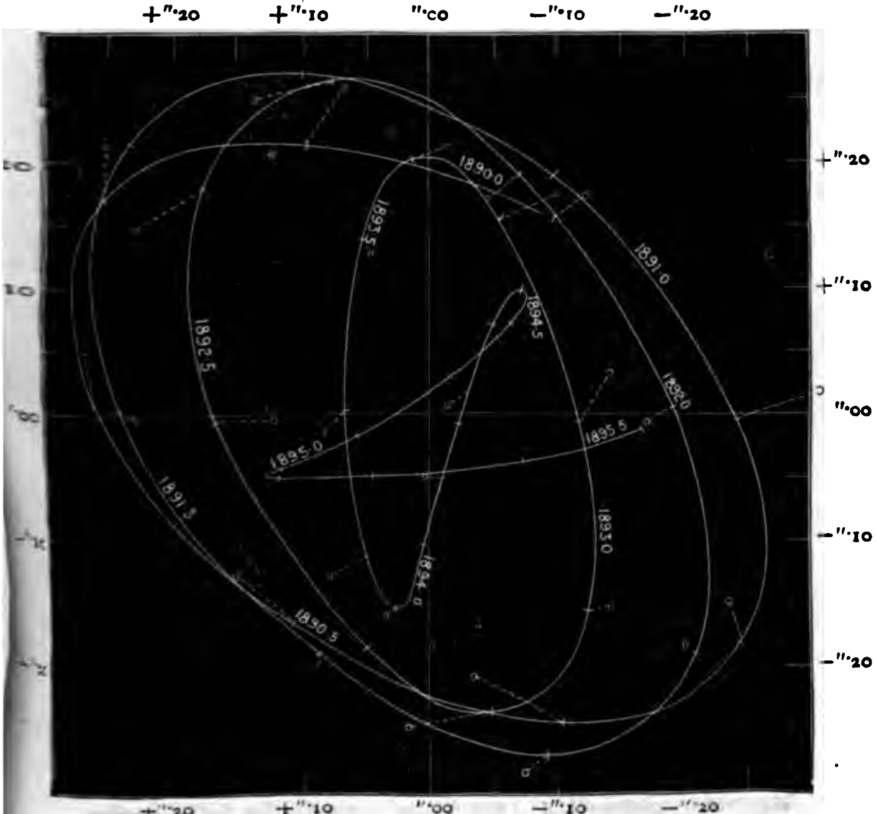
Taking the distance AC as 7″·7 this makes the two stars separated 52·7 times the distance of the Earth from the Sun, or 10 times that of Jupiter from the Sun.

The position for 1900 is R.A. 11$^h$ 8$^m$ 40$^s$, N.P.D. 15° 59′; and magnitudes A=7·0, B=7·5, C=12. THOMAS LEWIS.

---

## *The Variation of Latitude.*

In recent numbers of the 'Astronomical Journal' Dr. S. C. Chandler has developed a new feature in his theory of the motion of the Earth's axis of rotation about its axis of figure, or of the axis of figure about the axis of rotation, which are alternate ways of regarding the same fact. It will be remembered that according to the theory this motion is represented by a formula of two circular functions of different amplitudes and of periods respectively, a year and about fourteen months. The new development shows that the component whose period is a year really indicates motion in an ellipse of large eccentricity with a major axis about 0″·3 in length, inclined to the Greenwich meridian about 45° to the west, if we regard the pole of figure as the origin and the pole of the axis of rotation as the moving point. This conclusion has been derived from the results of the observations made under the auspices of the International Geodetic Association in the years 1890–93, purposely to detect the latitude variation, at the eight stations, Poulkova, Prague, Berlin, Strasburg, Rockville, San Francisco,



Waikiki, Bethlehem (Pennsylvania). In the 'Astronomical Journal,' No. 329, Dr. Chandler gives a diagram, which is reproduced above, showing the curve in which the pole of figure would move with reference to the pole of rotation according to his amended formula

$$x = +0''{\cdot}16 \sin(t - 241\ 1790)\ 0^\circ{\cdot}85 + 0''{\cdot}11 \sin(\odot - 300^\circ),$$
$$y = +0''{\cdot}16 \cos(t - 241\ 1790)\ 0^\circ{\cdot}85 + 0''{\cdot}11 \cos \odot,$$

in which the constants are determined from the above-mentioned observations. The positive direction (up) of the axis of $y$ represents the Greenwich meridian, the positive direction of the axis of $x$ is to the left, and represents the meridian 90° E. The small lines crossing the curve represent the position of the moving pole at 50-day intervals, and the approximate dates are given in some cases. The small circles represent the positions of the pole as deduced from the observations, and it may thus easily be seen how nearly the observations agree with the formula. The agreement of the later ones, the last two of which were not used in evolving the formula, with the curve are particularly striking, as the involved form of the curve makes this a critical test. It will be interesting to watch if observations during 1894 and 1895 agree with the line as predicted in this diagram. "The agreement will form a crucial test of the reality of this elliptic motion." This diagram is useful for another reason. One may determine from it by inspection the amount of latitude variation in any longitude and at any time. The difference of latitude from the mean in longitude $\lambda$ is given by the formula

$$\phi - \phi_0 = x \sin \lambda - y \cos \lambda.$$

Hence drawing a line through the centre to represent the longitude $\lambda$, and taking the point on the curve corresponding to the time chosen, and drawing a perpendicular from the point on the line, the distance between the foot of this perpendicular and the centre will represent $\phi - \phi_0$. It will be seen from this that the variation of latitude near the Berlin meridian during the latter half of 1894 will be almost imperceptible, while at Bethlehem and Columbia College it will increase by a quarter of a second in the same time.

This subject was referred to at the Congress of the Geodetic Association held at Insprück in September last. D. Förster made an interesting communication to the Congress giving the result of a discussion of the observations, 6000 in all, made at Kazan, Strasburg, and Bethlehem. The twenty positions of the pole deduced from these for each month from 1892 October to 1894 March give a curve which shows some similarity to Dr. Chandler's. Prof. Bakhuyzen also read a memoir at the Congress treating the matter of latitude variation in rather a novel way, which is described in the following translation of a paragraph from the account of the proceedings of the Congress given by M. Tisseraud in the 'Annuaire du Bureau des Longitudes' for 1895:—

"If the Earth were entirely covered by seas and the interior nucleus symmetrically constituted, the level surface would be that of an ellipsoid of revolution. If the position of the axis of rotation differed from that of the axis of figure by a small quantity, the equator would be displaced by a small quantity. There would be then two level surfaces corresponding to the two conditions, and a point of the surface at first on a certain radius will be found on the second hypothesis at a distance from the centre differing a little from the first. The mean sea-level at any given point ought therefore to vary a little, and will suffer a variation with the same period as the displacement of the pole. One is therefore led to examine if this mean level varies with a period of fourteen months. M. Bakhuyzen has chosen numbers taken from the tide records of the Helder from 1851 to 1893. It is known that the tide-observations of Holland have exceptional interest, and also they are made with very great care. The figures which have been communicated to us show well the fourteen-month period. The greatest divergences are about 14$^{\mathrm{mm}}$, and correspond to a change of latitude which is of the order of variation determined by other methods."

---

## *Selenographical Notes.*

Blancanus and Scheiner.—The surpassing attractions of the neighbouring Clavius tend to render the interesting details of this remarkable pair less notable to the observer than would be the case if the formations were not so closely associated. At a phase of morning illumination when the floor of Clavius is practically in full sunshine, the whole of Blancanus, except the higher portions of the eastern rampart (at one point 18,000 feet above the depressed interior), is involved in black shadow, while no part of its companion, Scheiner, is visible. Under these conditions of illumination the internal terraces below the summit ridge are seen to great advantage, as are also many included little craters and depressions, mostly unrecorded. In the January number of 'Sirius' Herr J. N. Krieger gives a drawing of the formation, made at Gern-Nymphenburg, 1894 September 21, 13$^{\mathrm{h}}$ under evening illumination; in which he shows 16 craters on the floor, the majority being situated on the south-eastern quarter of it. Most of these objects have not been previously noted. Mädler draws only three,—the prominent crater A, south of the centre, and two minute objects between this and the foot of the south wall. Schmidt shows these, and three in addition on the south-east of A, and a group of small mountains abutting on the northern flank of A. These also are well represented by Herr Krieger, whose drawing agrees very fairly with that of Schmidt. At 9$^{\mathrm{h}}$ April 8, 1892, when the floor was nearly free from shadow, I saw with a power of 284 on my 8½" reflector, five craters in addition to A, four of which seem to answer, as regards position, to those shown at the foot of the south-east wall. At 9$^{\mathrm{h}}$ February 5, 1895, under nearly the same conditions, I again observed the five previously recorded, but, with all attention, no more. The fact that Herr Krieger's drawing was made under a setting Sun probably accounts for the discrepancy between the records.

Observing Scheiner on the date last mentioned, the crater A, nearly central, and five others, almost as prominent, were easy objects,—three in a row on the north of A, aligning with a large bright shallow depression on the inner slope of the north-east wall, and the remainder standing close to the foot of the east wall, just below a somewhat smaller but very similar object on its slope. At a somewhat later stage of sunrise, I saw several minuter craters and pits on the northern quarter of the floor, which appear to be unrecorded. It may be mentioned that Schröter (Sel. Top., t. 47) shows two minute objects in the interior on the north of A, which appear to represent two of the members of the row just referred to. Mädler's drawing of the interior features of Scheiner do not agree with that of Schmidt or with my own. Doubtless many who have consulted Schmidt's representation of this formation have endeavoured to verify the existence of the two linear ridges, which he shows so prominently, crossing each other a little east of the crater A, and extending from wall to wall. There is a number of low mounds on the southern quarter of the floor, and I have seen a row of such (very nearly in the position of the more southerly of his ridges), and a short ridge west of A, but have never succeeded in observing anything comparable, as regards definiteness, to the objects he draws thereon.

A ray from Tycho, passing west of Longomontanus to the eastern flank of Scheiner, and there apparently terminating; is an interesting feature under a moderately high Sun, mainly on account of its association with the eastern borders of a number of shallow rhomboidal enclosures lying between these formations.

Beaumont House, Shakespeare Road,
Bedford, 1895, Feb. 19.

T. Gwyn Elger.

---

## CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

### *Cassini and the Principal Division in Saturn's Ring.*

Gentlemen,—

Much as has been written respecting the history of the discovery of the principal division in Saturn's ring (Cassini's undoubted priority in which is even now sometimes overlooked, as was lately pointed out in the 'English Mechanic' by "A Fellow of the Royal Astronomical Society" in reference to a paper by Prof. Hastings), yet it may be worth while, as the early volumes of the 'Memoirs' of the French Academy are not very accessible, to give in full Cassini's first description of this from those 'Memoirs,' Tome x. p. 583, which runs thus:—

"Après la sortie de Saturne hors des rayons du Soleil l'an 1675 dans le crepuscule du matin, le globe de cette Planète parut avec une bande obscure semblable à celles de Jupiter, étendue selon la longueur de l'Anneau d'Orient en Occident, comme elle se voit presque toujours par la Lunette de 34 pieds, et la largeur de l'Anneau étoit divisée par une ligne obscure en deux parties égales, dont l'intérieure et plus proche du globe étoit fort claire, et l'intérieure un peu obscure. Il y avoit entre les couleurs de ces deux parties, à peu près la même différence qui est entre l'argent mat and l'argent bruni (ce qui n'avoit jamais été observé auparavant,) et ce qui s'est depuis vû toujours par la même Lunette, mais plus clairement dans le Crépuscule et à la clarté de la Lune, que dans une nuit plus obscure.

"Cette apparence donna une idée comme d'un anneau double, dont l'inférieur plus large et plus obscur fût chargé d'un plus étroit et plus clair.

"Cela fit ressouvenir que l'an 1671, lorsque les bras de Saturne étoient prêts de disparoitre, ils se racourcirent auparavant, peut-être parceque la partie extérieure de l'anneau qui étoit simple et obscure disparut avant la partie inférieure qui étoit double et plus claire."

Does not this language seem to indicate not only the existence of two rings, but also a division, or at any rate a difference of brightness in the interior ring? For he says that in 1671 the outer and less bright ring disappeared before the interior part (or ring), which was double and bright. Otherwise, too, the former part is surely ambiguous. He says there "l'intérieure et plus proche du globe étoit fort claire," and then "l'intérieure" (is this a slip for *extérieure*, or does he mean the interior part of the interior and brighter ring?) "un peu obscure." It seems to me he must have noticed a shading-off of the interior ring into the part we now call the dusky ring.

Cassini gives two views of Saturn, in one of which the ball envelops the ring, whilst in the other it does not appear to reach the outer edge of the ring, and then says:—

"Il y a une Observation de M. Hevelius dans le Journal d'Angleterre, qui répond à la première de ces deux phases; mais comme il n'a pas marqué ni la bande de Saturne, ni la distinction qui se voit dans l'anneau, on a sujet de juger que les Lunettes dont il se sert sont beaucoup inférieures à celles de l'Observatoire Royal."

I presume the "Journal d'Angleterre" must mean the 'Philosophical Transactions'; and the reference is to two views of Saturn taken by Hevelius at Danzig in August and September, 1670, and appearing in No. 65 of the Phil. Trans. (vol. iv.). At those times the apparent breadth of the ring was very much less than the diameter of the ball of the planet.

Yours faithfully,

Blackheath, 1895, Feb. 4. W. T. Lynn.

## *The Comet of* 1525.

GENTLEMEN,—

I have endeavoured without success to obtain any particulars respecting this comet, which, if we are to judge by the expression used in Herman Grimm's 'Leben Michel angelo's,' must have been a large one. He says, "Das Jahr 1525 war kein günstiges ...... Ein komet am Himmel, der die Furcht erregt, die ganze Welt werde durch eine neue Sündfluth zu Grunde gehen." No authority is given. Pingré refers to David Herlicius as mentioning a comet in that year, but furnishes no particulars. As no date appears, it is possible that it was the comet which, according to Pingré, was mentioned by Luther as seen in December 1524, though he had searched in vain for any reference to it in his works. A "horrible comet, resembling an inflamed sword," was seen in the autumn of 1526, but this could hardly be the one alluded to by Grimm. Perhaps some of your readers versed in the history of those times may be able to throw light upon the matter.

Yours faithfully,

Blackheath, 1895, Feb. 16. W. T. LYNN.

P.S.—Since writing the above, I have had an opportunity of consulting Herlicius's tract on the comet of 1618, in which, as Hevelius (followed by Pingré) remarks, he refers to some comets seen in the preceding century. Of the one in question he only says that the Peasants' War followed the appearance of a comet, in the year 1525. Now the Peasants' War lasted from January until the summer of that year, so that it is doubtful whether the comet was seen in 1524 or 1525. Herlicius quotes several passages in which Luther expresses the view that comets and eclipses portended the occurrence of some calamity, but none in which he mentions the appearance of any particular comet.

W. T. L.

## *Variable Orange Stars.*

GENTLEMEN,—

I have been observing some of the stars in Mr. Espin's Red Star Catalogue for many years, and on December 19, 1894, observed the one in Pisces alluded to by Mr. Backhouse in his letter to you of January 24 (18 Birmingham). I find it described in my note-book as decidedly red, or orange-red; magnitude, roughly estimated, 7 or 6·5.

Evening clear, no moon.

I have often suspected variability in red stars, but, owing to the difficulty of obtaining comparison stars, it is not always easy to estimate their magnitude.

When unable to identify them, I have sometimes thought it might be due to their being at a minimum, and therefore not within the range of my 6½-in. reflector, or else that they were too faint for any estimate of colour to be possible.

Yours faithfully,

Further Barton, Cirencester, 1895, Feb. 4. E. BROWN.

### *Planetary Spectra.*

Gentlemen,—

In discussing the effect of the humidity of our atmosphere upon observations of planetary spectra, in the 'Observatory' for January, I had in mind the relative *quantities* of water-vapour which are traversed by rays from the planets, and not the relative degrees of saturation. Unfortunately, I used the term *relative humidity* to express my meaning: Professor Young has kindly called my attention to the fact that I should have used the term *absolute humidity*. I regret the mistake. He also suggests that the critical water-lines would be weaker at low temperatures than at high ones, because, according to Kirchhoff's law, the radiating power of the molecules (and therefore the absorbing power) diminishes with lowered temperatures.

Yours truly,

Mt. Hamilton, 1895, Feb. 1. W. W. Campbell.

---

## OBSERVATORIES.

**Wolsingham.**—In the report of the work of his observatory for the year 1894, the Rev. T. E. Espin writes as follows:—"During the year the sweeps for stars with remarkable spectra have been continued. The total number of objects observed is 1044; of these 498 are new objects. The large number discovered has caused their publication to take the same form as last year. Only 112 stars have been included in the principal list, and the others have been simply announced by their B.D. number. Several new fourth-type stars have been detected. On account of the increasing number of suspected variables some time has been devoted to careful estimation of their magnitude. 57 stars are under observation for variation, and 249 comparisons have been made of these. Seven new variables have been detected in the course of the year."

The report also refers to the publication of the second volume of 'Celestial Objects,' and regretfully to the death of Mr. George Knott, who had always been a good friend to the observatory.

The cost of replacing the dome, the wrecking of which during the gale of December 22 was mentioned in our last number, has been generously defrayed by Captain Jessop and Mr. C. L. Brook.

---

## PUBLICATIONS.

**The Radcliffe Catalogue for 1890.**—It is not from any want of appreciation of its merits that we have not referred before this to Mr. Stone's Catalogue, which was published in November of last year, but the delay is rather due to the fact that a monumental work of this kind is not to be hastily d with.

This Catalogue of 6424 stars, reduced to the epoch 1890, is result of the observations made under Mr. Stone's directio Oxford during the years 1880–1893, with the Transit Circl the Observatory, which is described in the Introduction to Carrington's Redhill Catalogue, 1855. The main object of efforts is stated by Mr. Stone to be "to obtain positions of s for well-distributed zero-points between the Equator and N. 115° *in continuation and completion of the work carried out u my direction at the Cape of Good Hope between the years* 18 1879. The present Catalogue should contain the positions of the stars to the seventh magnitude from the Equator to 1 N.P.D., except those in clusters . . ." Besides such stars m stars were observed by reflection and directly, and many at and below pole, to test the accuracy with which Bessel's refracti satisfied the Oxford observations; and, again, many stars be 115° N.P.D., for comparison with the places of the Cape Catalo 1880, also with the view of investigating the law of refraction.

The volume itself is after the pattern of Mr. Stone's C Catalogue 1880, large quarto in size, the line referring to each extending across a double page. The Right Ascensions are gi to three places of decimals, but it is stated in the Introduc that no importance is attached to the last decimal place. precessions and secular variations, computed by means of Pet constants, are given for each star, and for some stars, abou quarter of the whole number, Proper Motions are given, man which have been determined in the formation of the pre Catalogue, and others taken from Prof. Auwers' 'Catalog Fundamental Sterne' or from other authorities. Some atten has been paid to the magnitude of the stars by the observers. the case of some stars, generally the brighter ones, the magnit as given in published catalogues is given, but in other cases magnitude as estimated by the observers on Argelander's scale, in a column of the Catalogue we have the number of such e mations on which the published magnitude is based. Follow the plan of the Cape Catalogue, reference numbers are give six other catalogues.

As to the zero of Right Ascension of the Catalogue, the cl stars used in reducing the observations were those of Greenwich clock-star lists except in 1893; but whereas these l for the years 1880–1887 depend on the places of the Green catalogue of 1872 brought up with Bessel's proper motions, observations in these years have been corrected to reduce them system of clock-stars depending on the places of the 1872 Catalo reduced with Auwers' proper motions.

From 1889–1892 the Greenwich lists give the places of Greenwich 1880 Catalogue, brought up with these same Pr Motions, and Mr. Stone used a similar list for 1893; so that

Right Ascensions depend either on the Greenwich Catalogues of 1872 or 1880 brought up in both cases with the Proper Motions deduced by Prof. Auwers. Beyond this, observations of the Sun were made at the Radcliffe Observatory during the years 1884–1891, and from these a mean correction to epoch $+0^{s}\cdot014$ has been deduced and applied to all the Right Ascensions of the catalogue. The discussion of these solar observations also gives a correction to the co-latitude, or, what is the same thing, a correction to be applied to the North Polar Distances of the Catalogue $-0''\cdot015$, and a correction to the assumed Obliquity of the Ecliptic $+0''\cdot199$.

The mean of the corrections to the obliquity, as found from observations of the Sun at Greenwich in the same years, is $+0''\cdot25$.

As to the North Polar Distances of the Catalogue, the adopted co-latitude of the Transit Circle is $38^\circ\ 14'\ 24''\cdot61$. The zenith-point reading was determined exclusively from observations of the nadir. A flexure correction has been applied derived from observations of the horizontal collimators varying from $1''\cdot10$ sin Z.D. to $1''\cdot25$ sin Z.D. No correction for discordance between the results of observation of stars by reflexion and directly has been applied, and the refractions down to zenith-distance 85° have been computed from Bessel's 'Tabulæ Regiomontanæ.'

As to the propriety of the adoption of these methods in forming North Polar Distances it hardly becomes us to speak. For these involve debated questions, about formation of zenith-points, flexure, and application of empirical corrections, on which no person is yet competent to express a final opinion. Mr. Stone has himself furnished some evidence on the correctness, or the reverse, of his methods by a comparison of the places of the Radcliffe Catalogue now before us with those of the Greenwich Catalogue for 1890 (M.N.R.A.S. Nov. 1894). As is well known, the methods adopted at Greenwich with regard to the points above detailed are in direct contradiction to those used at the Radcliffe Observatory, the zenith-point is formed from the results of reflexion observations of stars, north and south of the zenith, in combination with nadir observations, no flexure is applied, but a correction deduced from the differences shown by the N.P.D. of stars observed directly and by reflexion is applied. The result of this comparison shows that the Greenwich North Polar Distances from the zenith to N.P.D. 108° are larger than those of the Radcliffe Catalogue by about $0''\cdot8$, practically constant throughout the range. This difference is larger for stars of greater N.P.D. and varies considerably between the Pole and the Zenith. Mr. Stone in his paper in the 'Monthly Notices' guardedly hints that this excess may be partly due to the R – D correction applied to the Greenwich results, which is, in the mean, about half of the quantity above mentioned. We think it is equally fair to suggest that the difference may be due to the want of an R – D correction to the Radcliffe results. The results of the reflexion and direct observations given in the annual volumes of the Radcliffe Observatory certainly do not show complete accordance. As we have said, the application of half the difference R−D to all direct observations is a practice often questioned. It was adopted by Sir George Airy from considerations given in 'Mem. R.A.S.' vol. xxxii. p. 9, and it does not appear that the evidence given by the comparison of these catalogues is sufficient to warrant its discontinuance. But it is by the accumulation of such evidence that the truth on this point will be arrived at. Mr. Stone has also made a comparison of his new work with his Cape Catalogue of 1880. Another Cape Catalogue for epoch 1885 is just to hand, which will afford further valuable data for discussion, and, whatever be the final outcome, it will certainly be felt that Mr. Stone has worthily done his share, and everyone will agree, as we do, with the last paragraph of the Introduction to this Catalogue: "No means of securing accuracy in the results which experience has suggested to me have been neglected, and I hope and believe that the present Catalogue will compare not unfavourably with those which have been issued from other Public Observatories."

---

THE 'NAUTICAL ALMANAC' FOR 1898.—A much-needed addition has been made to the British Ephemeris in the annual volume recently published. The apparent places of eleven close circumpolar stars, to be used for determining azimuth error, four of which are in the northern hemisphere, are now given for each day of the year. Besides this, the mean places of 52 stars for the use of sailors are added to the catalogue; the daily apparent places of these are not given. This latter list was increased by 120 stars in the volume for 1897. As evidence of the fact that the computations are based on the latest available data, it will be noticed that Dr. See's elements have been used in computing the relative components of the double star $\alpha$ Centauri. Improvements in the explanation given at the end of the book have been made in recent volumes of the 'Nautical Almanac.' Especially is this the case in the sections relating to eclipses and occultations. In the 1898 almanac there is given, as a specimen, the computation of the approximate local mean times of beginning and ending of the eclipse on 1898, January 21, for a station in India, and also the circumstances of the occultation of a certain star as seen at the Cape Observatory, both of which are instructive. It may be mentioned that the computation of the eclipse is effected by means of the Besselian system of co-ordinates, which are now used in the 'Nautical Almanac' Office.

---

L'ANNUAIRE DU BUREAU DES LONGITUDES.—The Paris Bureau des Longitudes has nearly lived its century. We see from the introduction to the 'Annuaire' that it was created by a law of the National Convention dated 1795, June 25; but, judging from its annual ephemeris, "age does not wither nor custom stale its infinite variety," for, in the volume for 1895 now before us, we find the usual varied assortment of instructive facts. The Calendar and Astronomical Phenomena, including Ephemerides of Variable Stars (which we are privileged to use in forming our "Companion"), Elements of Binary Stars, the list of which is added to by M. Glasenapp, and Tables of Comets and Small Planets brought up to date; statistical tables relating to the French nation, and many tables giving physical and chemical constants and data—the thermochemistry being revised and added to this year by M. Berthelot and the terrestrial magnetism by M. Moureaux. The book also contains five interesting memoirs, two of which relating to the Geodetic Congress and the change of the astronomical day, we have referred to on other pages; the others are respectively: on Lunar Atmospheric Tides, by M. Bouquet de la Grye, giving some interesting comparisons of meteorological phenomena with the phase of the Moon; on Photographic Photometry, by M. Janssen; and on the Meteorological Instruments of the Mont Blanc Observatory, by the same author. Forming altogether much interesting and instructive reading.

---

Le Service Chronométrique à l'Observatoire de Genève, avec une étude des épreuves instituées dans d'autres Observatoires pour les Chronomètres de Poche.—To those interested in the development of horological instruments this book will be extremely useful. To the ordinary reader it will afford a fund of information, as M. Gautier has expounded the methods pursued in the various observatories engaged in purchasing chronometers for the navy and mercantile marine. For instance, the methods adopted at Geneva, Neuchâtel, Yale College, U.S.A., Kew, Besançon, Hamburg, Greenwich, and Paris are fully treated of.

---

Annuaire de l'Observatoire Royal de Belgique.—We have also received a copy of this annual publication, which contains the usual astronomical information and statistical tables for Belgium; some papers on the subjects of nutation and aberration, with which M. Folie's name has of late years been associated; and a long memoir on the climate of Belgium, by M. Lancaster.

---

Remarkable Comets.—We are glad to welcome the third edition of Mr. Lynn's book under the above title. We still hold the opinion that we did when in writing of the first edition we spoke of its utility and cheapness, and are not surprised that a third edition has been called for. The book is brought up to date (January 1895), the Eclipse Comet of April 1893 and the similarity of the orbits of Edward Swift's Comet and De Vico's both being referred to. The recent brilliancy of Encke's Comet must have happened just too late to be included, or Mr. Lynn no doubt would have modified a sentence on p. 18.

## NOTES.

**Comet Notes.**—M. Kromm has deduced the following definitive orbit for Comet 1893 II. (Rordame-Quénisset):—

Epoch 1893 July 20·5 Paris M.T.
T=1893 July 7·277946 Paris M.T.

$$\left.\begin{array}{ll} \omega \ldots\ldots & 47^\circ\ 7'\ 46'' \\ \text{☊} \ \ldots\ldots & 337\ \ 21\ \ \ 2 \\ i \ldots\ldots & 159\ \ 58\ \ \ 2 \end{array}\right\}\ 1893{\cdot}0$$

$$\begin{array}{ll} \log q \ldots\ldots & 9{\cdot}82901 \\ e \ldots\ldots & 0{\cdot}99946 \end{array}$$

The resulting period is 44410 years; planetary perturbations have been taken into account.

Dr. Berberich has published (Ast. Nach. 3260) the following elements of Comet 1884 II. (Barnard), which is due to return to perihelion about June 3 next:—

Epoch 1895 Feb. 9·0 Berlin M.T.

$$\begin{array}{ll} M \ \ldots\ldots & 339^\circ\ \ 8' \end{array}$$

$$\left.\begin{array}{ll} \omega \ldots\ldots & 300\ \ 59 \\ \text{☊} \ldots\ldots & 5\ \ 13 \\ i \ldots\ldots & 5\ \ 28 \end{array}\right\}\ 1890{\cdot}0$$

$$\begin{array}{ll} \phi \ldots\ldots & 35\ \ 43 \\ \mu \ldots\ldots & 656'' \\ \log a \ \ldots & 0{\cdot}4886 \end{array}$$

A search ephemeris is also given extending from April 24 to July 5.

Dr. Hind has published (Ast. Nach. 3271) the following elements of Comet 1892 V. (Barnard):—

T=1892 Dec. 10·50272 G.M.T.

$$\left.\begin{array}{ll} \pi \ldots\ldots & 16^\circ\ 19'\ 25'' \\ \text{☊} \ldots\ldots & 206\ \ 26\ \ \ 6 \\ i \ldots\ldots & 31\ \ 18\ \ 42 \end{array}\right\}\ 1892{\cdot}0$$

$$\begin{array}{ll} \phi \ldots\ldots & 36\ \ 25\ \ 41 \\ \log a \ \ldots & 0{\cdot}54785 \\ \text{Period} \ldots & 2423{\cdot}104 \text{ days.} \end{array}$$

The next perihelion passage, according to these elements, will take place on 1899, July 30.

Mr. Sperra, of Randolph, Ohio, noticed a conspicuous tail to Encke's Comet on January 17; it was over a degree in length, and slightly curved to the southward (Popular Ast., Feb.).

Prof. Barnard obtained observations of E. Swift's Comet on five nights at the end of January, bad weather having prevented earlier observations. Its brightness did not exceed that of a 17th magnitude star. With the aid of these very valuable observations, Dr. Chandler has deduced the following elements:—

$$\begin{array}{ll} T = 1894 \text{ Oct. } 12{\cdot}1882 \text{ G.M.T.} & \\ \omega \ldots\ldots\ 296^\circ\ 34'\ 35'' & \left.\begin{array}{l}\\ \\ \\ \end{array}\right\} 1894{\cdot}0 \\ \Omega \ldots\ldots\ \ \ 48\ \ 44\ \ 37 & \\ i \ldots\ldots\ \ \ \ \ 2\ \ 57\ \ 54 & \\ \log q \ldots\ 0{\cdot}143645 & \\ e \ldots\ldots\ 0{\cdot}571895 & \\ \text{Period} \ldots\ 5{\cdot}8633 \text{ years} = 2142 \text{ days.} & \end{array}$$

A. C. D. C.

**Minor Planet Notes.**—Mr. B. M. Roszel has recently published an investigation of the total mass of the first 311 asteroids (Johns Hopkins University Circular, January 1895). He starts with the assumption that they all have the same albedo as Vesta (with the exception of Ceres and Pallas, for which he uses Prof. Barnard's diameters) and the same density as Mars. The total mass comes out as follows:—

| | Mass. |
|---|---|
| (1) From Pickering's estimate of diameter of Vesta, assuming albedo = that of Mars | 0·00112 of Mars. |
| (2) From Muller's estimate of diameter of Vesta, assuming albedo = that of Mars. | 0·00336 ,, |
| (3) From Muller's estimate, assuming albedo = that of Mercury | 0·00666 ,, |
| (4) From Barnard's measures of Vesta | 0·00273 ,, |

The mean diameter of Mars is taken as 4230 miles. The indicated mass of the group is about $\frac{1}{40}$ of that of the Moon.

Four new planets—BP, BQ, BR, BS—were discovered by Wolf on Feb. 23 and 25.

A. C. D. C.

**Prof. Stockwell on Ancient Indian Eclipses.**—We have received a note from Prof. Stockwell, too long for insertion, with reference to Herr Ginzel's attempt to determine the date of the 'Rig Veda' by eclipses, abstracted in our number for November 1894 (p. 373). He informs us that he, too, has calculated the circumstances of the four eclipses referred to, with somewhat different results from those obtained by Herr Ginzel, the differences probably arising from the values of the secular acceleration adopted. Using himself about 8″, he finds that the eclipse of B.C. 1250, March 4, occurred about noon at Lahore, and that about 7 digits were eclipsed there; that of B.C. 1301, Nov. 17, took place about half-past 2 o'clock in the afternoon, and was annular at Lahore; and the third, on B.C. 1386, Nov. 28, was very small at Lahore, but in the southern part of India the Sun would probably be considerably more than one half eclipsed. With regard to the fourth eclipse mentioned in the 'Rig Veda,'—which

Prof. Ludwig thought was subsequent to the above three, but as to which Herr Ginzel, after examining by the aid of Schram's tables all the eclipses which occurred back to B.C. 2000, could find only one, in B.C. 1978, Oct. 5, which appeared to fit the circumstances,—Prof. Stockwell has also examined it, with (as in the other cases) a result differing in detail. Instead of finding, with Herr Ginzel, that the central line passed over India from Bombay to Madras, and that the eclipse was large at Lahore, he makes it central and annular at noon in latitude 6° south, and longitude 74° 36′ east, at which time the northern limit of the penumbra only reached the latitude of 27° north, so that the eclipse was wholly invisible at Lahore. This would be fatal to its being mentioned in the 'Rig Veda'; Prof. Stockwell thinks that its occurrence on the sixth instead of the third day before the autumnal equinox also inconsistent with this. But Herr Ginzel considered a margin should be allowed in this respect, the day of which was taken by Prof. Ludwig from another ancient Indian writing. Availing himself of some very important and simple relations between the motions of the Sun and Moon (too complicated to be explained in his paper), Prof. Stockwell has made an effort to discover the date of an eclipse which should be nearly central at Lahore, and occur on the actual third day before the autumnal equinox. He finds one (and none later) which occurred in the year B.C. 3784, on Oct. 20, and therefore proposes to carry back the date of the 'Rig Veda' very much further. If so, we must quite reject Prof. Ludwig's idea that the fourth eclipse mentioned was later than the other three.

W. T. L.

---

ON THE DISTRIBUTION OF STARS IN THE MILKY WAY.—M. C. Easton, whose beautiful drawings of the Milky Way will be remembered, is making an investigation of the distribution of stars in the Galaxy. He publishes an account of his method and his results, so far as he has at present gone, in Ast. Nach., No. 3270. The method is to take a region of the sky, and having divided it into equal areas, to count the stars of each half-magnitude down to 9·5 in each part, using Argelander's 'Durchmusterung' for this, and also to count the whole number of stars down to the 11th magnitude, as given in the Catalogue of Prof. Celoria. A comparison is made of this tabulation with the apparent brightness of the Milky Way in the selected regions, to show if the density of stellar distribution coincides with the galactic density or *vice versâ*. The regions already treated in this way are one in Aquila and another in Cygnus, which are divided into sections about five degrees square, and comparison of a region with that adjacent to it shows that increase of star-density coincides with increase of galactic brightness. M. Easton is alive to the fact that it may be the presence of faint stars which causes the appearance of the Milky Way to the naked eye, and has made a subsidiary inquiry into this point, which, to some extent, negatives this view, although he is of opinion that some local accumulations of stars may explain curious discrepancies in drawings of the Galaxy hitherto published. M. Easton thinks that the results of his work are in contradiction to the hypothesis of a distribution, relatively uniform, of stars and groups of stars in the plane of the Galaxy. In conclusion, M. Easton asks for collaborators who would help in this work, which is of considerable magnitude, but within the capacity of most persons having sufficient leisure, as no instrument is required. If anyone who wishes to help in this systematic investigation of the Milky Way will put himself in communication with M. C. Easton, Dordrecht, Holland, cards and instructions will be forwarded.

---

On the Relation between the Parallaxes of Stars, their Magnitudes, and their apparent Proper Motions.—An investigation of this interesting subject by Prof. Hugo Gyldén was published in Ast. Nach., No. 3258. Taking as material for discussion the observed parallaxes of 56 stars, their proper motions on a great circle, and their magnitudes, he arranges these stars, first in order of the magnitude of proper motion, secondly in order of the magnitude of the stars, and, having grouped them, takes means of the above-mentioned quantities, indicated respectively by the letters $p$, $s$, and $m$.

An inspection of the resulting means of the first arrangement leads to the adoption of a formula of the form

$$p_m = \mathrm{P}_m \,.\, e^{ks},$$

where $\mathrm{P}_m$ is the parallax of a star of magnitude $m_1$, which has no proper motion, and $p_m$ is the parallax of a star of like magnitude, but with proper motion $s$.

The second arrangement leads to the adoption of a formula connecting the parallax of stars with the magnitude, assuming the proper motion to be zero, that is, $\mathrm{P}_m$ is now a function of $m$ of the form $\mathrm{P}_1 e^{-0{\cdot}215(m-1)}$.

Applying this formula to the above-mentioned data, a value $0''{\cdot}204$ is found for the mean parallax of stars of the first magnitude, on the assumption that they have no proper motion, which agrees with Peters' value of the same quantity $0''{\cdot}209$, and a first approximate formula,

$$p = 0''{\cdot}204\, e^{-0{\cdot}215m + 0{\cdot}200\sqrt{m}\,.\,s},$$

is found connecting the quantities $p$, $m$, and $s$, the scale of $m$ being such that the magnitude of Arcturus is represented by zero.

---

The Probable Revolution of the Orbit of Phobos.—Prof. W. W. Campbell states in the 'Astronomical Journal,' No. 332, that his observations of the inner satellite of Mars, made between 1894 Oct. 25 and Nov. 15, showed that the easter elongation occurs at a considerably greater distance from th planet than the western elongation does, whereas observations b Prof. Hall in 1877 showed that on the contrary the wester elongation-distance was then greater than the eastern. Havin taken into account the difference in the relative positions of th Earth and Mars at these times, he ascribes the fact to a revolutio of the line of apsides of the orbit of the satellite. The sam thing is also suspected in the case of Deimos, but Prof. Campbel says that the evidence in this case is not so conclusive, as th orbit is nearly circular. It happens, however, that in 'Astronomical Journal,' No. 331, Mr. W. S. Harshman published th elements of the orbit of Deimos, determined by him from observations at Washington made in 1892, which show an apparen motion of the peri-centre of the satellite of about 258° a compared with elements by Prof. Hall from his observations o 1877. This is a striking confirmation of Prof. Campbell's conjecture.

---

THE GREAT FROST OF FEBRUARY, 1895.—By the kind permission of the Astronomer Royal we are enabled to give th following particulars derived from the Royal Observatory record with regard to the recent frost.

The commencement of the year, until the 13th of January, wa characterized by somewhat cold weather, the mean temperatur for the thirteen days being 32°·3,—a brief period of warmt following until the 20th. On the 22nd of January a frost of grea severity set in and lasted without intermission until the 20th o February, a period of 30 days. During this frost, short an concentrated as compared with many of recent years, a temperatur was recorded at the Royal Observatory lower than any previousl recorded in the month of February during the past half-centur On February 8th the lowest temperature registered was 6°·9, th lowest previously recorded in February having been 7°·7 on th 12th of February, 1845, whilst the lowest recorded in the notabl "Crimean" winter of 1855 was 11°·1 on the 19th. Lower value than that cited above have been recorded since 1841 on tw occasions only, both in January, viz., on the 9th of January 1841 4°·0, and on the 5th of January 1867, 6°·6. Other exceptionall low temperatures were recorded in the present month of Februar for example 9°·6 on the 7th, 10°·2 on the 9th, 14°·4 on the 10t 15°·1 on the 6th, and the temperature fell below 20° on no les than 11 days. The temperature remained below 32° throughou the day on eleven days in the month, whereas in the 54 year 1841–1894, a total number of 47 days only of similar characte had been recorded for February, nine of which occurred in 1855.

The four days, February 6 to 9 (the minimum values fo which are quoted above), were of unexampled severity, their mea daily values of temperature being 19°·4, 18°·3, 18°·9, and 18°

respectively, and although isolated instances of lower mean temperatures are on record—as, for example, 12°·8 on the 8th January, 1841, 13°·7 on the 4th January, 1867, 15°·9 on the 5th January, 1894, and 17°·4 on the 7th January, 1841—yet the mean value for these four days, 18°·6, stands out beyond all other examples for 4 consecutive days, as will be seen from the cases which follow:—January 6 to 9, 1841, 19°·3; January 2 to 5, 1867, 20°·5; January 4 to 7, 1894, 20°·8.

Similarly striking results are obtained for ten consecutive days:—

| | | | | |
|---|---|---|---|---|
| For | 1895, February 5 to 14 | the mean | temperature is | 22°·4 |
| „ | 1881, January 13 to 22 | „ | „ | 23 ·4 |
| „ | 1855, February 10 to 19 | „ | „ | 24 ·1 |
| „ | 1870, December 22 to 31 | „ | „ | 24 ·8 |
| „ | 1841, February 1 to 10 | „ | „ | 25 ·0 |

A comparison for 20 days February 1 to 20 can be established in one instance only, viz. between the present year and the year 1855, which it so closely resembles. Thus the 20 days (February 1 to 20) gave a mean temperature in 1895 of 26°·0, the mean of the highest daily values being 32°·6, and of the lowest daily values 19°·1. In 1855 the similar means were 27°·4, 33°·8, and 22°·7, but as the low temperature lasted a day or two later in 1855 than in the present year it is probable that the monthly means of temperature for the two months will differ but little. For the 20 days February 5 to 24 in 1855 the mean temperature is 26°·9. Taking the defect of each day's mean temperature from the average of 50 years for the period from Jan. 10 to Feb. 24 in 1855, the aggregate of these defects for the 46 days amounts to 467°. The similar aggregate defect for 39 days, from Jan. 21 to Feb. 28, for 1895 is 389°. A cold thaw set-in on the 21st February, and the daily temperatures have since risen slightly above 40°.

It is scarcely within the scope of this account to enter into details with regard to the damage and distress caused by this disastrous frost, but it may perhaps be well to mention that since 1855 the river Thames has never been so much blocked with ice as during the frost of the present month, completely stopping all navigation and communications in the Port of London.

W. C. N.

---

It is reported that a zone system of time, similar to that in use in America, has been adopted in Australia and New Zealand. No accurate information is to hand, but it is said that standard time of Wellington is 11 hours, of Melbourne, Sydney, and Brisbane 10 hours, of Adelaide 9 hours, and of Perth 8 hours, all fast on Greenwich.

---

The Unification of Civil and Astronomical Time.—The latest convert to the scheme for beginning the astronomical day at midnight, and, moreover, a most important one, is the Paris Bureau des Longitudes. In the 'Annuaire' of the institution almost all the phenomena are given for Paris Civil Time. In the edition for 1895 there is a notice by M. Poincaré on the subject of this change in the astronomical day and an account of the action taken by the Bureau in response to the circular recently issued by the Canadian Institute Committee. A resolution was passed in favour of the proposed change of origin of the day, and after agreeing with the opinion expressed by the Lords of the Admiralty that this change can only be made efficaciously by agreement between the governments which publish the principal ephemerides, the Bureau added that the unification of these days cannot be considered complete until the hours of the civil day are counted from 0 to 24, and expressed a hope that this may be realized as soon as possible.

In the same notice it is also pointed out that this is not the first time the subject has occupied the attention of the Bureau, for so long ago as 1804 February 24, it was proposed by Laplace, and the proposal was adopted, by 7 votes to 5, to begin the astronomical day at midnight, but the plan was never adopted in the ephemeris; Laplace, however, and other computers up to Le Verrier in calculating tables of the Moon and Planets adopted Civil Time.

---

In the 'Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg,' sér. 5, vol. i. nos. 1 and 2, will be found several astronomical papers, amongst them being a determination of parallax of $\beta$ Cassiopeiæ from observations at Poulkova in the prime vertical by S. Kostinsky:

$$\beta \text{ Cassiopeiæ} \ldots . \quad \pi = 0''\cdot167 \pm 0''\cdot072,$$

a very close agreement with the mean of the Oxford photographic determination ($0''\cdot154 \pm 0''\cdot018$).

Also the results of W. Seraphimof's physical observations of Jupiter in 1892–93 with the 15-inch Poulkova refractor, illustrated by a number of fine drawings.

And a discussion by G. Ivanof of the variation of latitude of Poulkova from observations in 1842–49, accompanied by a chart.

---

Dr. Andrew Russell Forsyth has been elected Sadlerian Professor in the University of Cambridge in succession to the late Prof. Cayley. Dr. Forsyth was Senior Wrangler and First Smith's Prizeman in 1881, and after being Professor of Mathematics in University College, Liverpool, for a short period, was appointed Assistant Tutor at Trinity College, Cambridge. He is well known as the author of three important treatises, two on Differential Equations, and one on the Theory of Functions. He is on the Council of the Royal Society, and is one of the Editors of the 'Quarterly Journal of Mathematics.' In addition to his teaching and tutorial duties at Trinity, he finds time not only to write books and memoirs, but also to take an active part in College and University business, and serves on various Committees and Syndicates.

---

The latest attempt to determine the rotation period of the Sun has been made by M. von Stratonoff, who has made a discussion of positions of faculæ, which is published in Ast. Nach., No. 3275. The results of this compared with the rotation period in different zones as obtained by Prof. Spoerer from spots, Dr. Duner from spectroscopic evidence, are as follows:—

| Mean Latitude. | From Faculæ. | Spoerer. | Duner. |
|---|---|---|---|
| ° | d | d | d |
| 0 | 24·66 | 25·09 | 25·46 |
| 15 | 25·26 | 25·44 | 27·29 |
| 30 | 25·48 | 25·81 | 31·83 |

---

Who would have thought that there was any connection between astronomy and the influenza? A writer in an evening paper has been interviewing a physician on the latter subject, and the physician is reported to have gravely suggested that, inasmuch as the epidemic is the effect of atmospheric causes, "we may be passing through a part of space filled with matter ejected from other planets." *Hinc illæ lacrymæ.* We may some day be able to publish the elements of the influenza-bearing orbit!

---

It is perhaps scarcely necessary to call attention to the Total Lunar Eclipse which will happen on Sunday, March 10. The circumstances of this eclipse are given in the 'Companion,' and also a list of the stars which will be occulted during or near totality. There is a small omission in this list. The star W.B. xi. 365, which is given as disappearing at $14^{h}$ $57^{m}$, will also reappear at $15^{h}$ $53^{m}$ at 348° from the N. point. Observations of times of disappearance or reappearance of all these stars will be valuable for giving a determination of the value of the Moon's diameter, especially of τ Leonis, which is a Greenwich Clock-star. A partial eclipse of the Sun will also happen on the morning of the 26th of the current month. A very small portion of the Sun will be seen eclipsed by observers in all parts of the British Isles, except in the district to the east of a line joining Hastings to Lowestoft. Times of the phases for some towns are given in the 'Companion.'

---

The 'Astronomical Journal' Prize of $200 for the best series of determinations of positions of comets between 1893 March 31 and 1894 Sept. 30, has been awarded to Prof. J. G. Porter, of Cincinnati.

The Prize of $400 for the discussion of the path of a periodic comet has not been awarded.

Herr Lindermann, of Poulkova, has published his results of observations, made in the four years 1891–4, on the brightness of stars in the cluster *h* Persei. In all he has observed 43 stars ranging from mag. 6·5 to 10·0. A chart is given and also a catalogue of magnitudes, not only his own, but also those of Krueger and those of Oertel.

The Astronomer Royal has been created an Honorary Freeman of the Spectacle Makers Company. He will be formally admitted on March 27.

Errata.—The R. A. of $\sigma^2$ Ursæ Majoris given on page 83, No. 224, as $8^h$ should be $9^h$.

On p. 96, No. 224, line 18, *for* "in." *read* m. (metres).

---

## From an Oxford Note-Book.

It was remarked in these notes two months ago that the Royal Astronomical Society, after carefully considering Dr. Gill's proposal for an Astronomical Conference at the end of the century, did not see their way to taking any initiative in the matter. Our attention has almost simultaneously been drawn to a question which would properly have come before such a Conference, and which will doubtless come before the controllers of the various national ephemerides. Professor Newcomb announces the practical completion of fifteen years' work on the constants of the solar system. A large part of a recent report by him was printed in our last number, and in No. 336 of the 'Astronomical Journal' he deals more fully with the results of his labours. It seems almost certain, firstly, that such labours must have resulted in a conspicuous improvement of planetary tables and constants; and, secondly, that if this improvement is to be recognized by the adoption of the new values uniformly in all ephemerides (and it is needless to dwell on the advantages of uniformity in such a case), the beginning of a new century is too valuable an opportunity to be lost. We may sincerely hope that there will be no delay in putting this question before the proper authorities in a definite and tangible form; in the case of our own 'Nautical Almanac,' for instance, the matter may be regarded as pressing, the volume for 1899 being already in course of preparation.

One of the most interesting points in the paper above referred to is "a discrepancy which during the past four months has caused Prof. Newcomb more embarrassment and trouble than all the other questions growing out of the work." The trouble is, in fact, that though evidence seemed to be accumulating in favour of a solar parallax of $8''\cdot800$ very nearly, yet the value of this constant deduced from the secular variation of the Earth comes out $8''\cdot759 \pm 0''\cdot010$. Prof. Newcomb has already remarked that the discrepancy may be explained on the hypothesis of a group of planetoids just outside the orbit of Mercury. But until independent evidence of such a *vera causa* is obtained, he is inclined to adopt the value $8''\cdot790$ for the solar parallax, changing the value of each planetary mass by as great an amount as appears admissible, to suit the secular variations. It is, however, impossible to give in this brief note a clear exposition of the point, for which a reference to the paper must be made.

Some of the phrases used by Prof. Newcomb in dealing with this point suggested to me (I can scarcely say how) a mechanical conception of the process of adjustment of related observations by least squares, which may be new. As an illustration, consider the measures of stars on a photographic plate, which are to be compared with known places. If the known places are set down as points on one sheet of cross-ruled paper, and the measured places on another, and if we put a pin through the two images of the same star, then one paper can only rotate on the other; possibly the images of a second star may be made to coincide and pinned, and then no further adjustment is possible *unless we enlarge the pinholes*. By suitably enlarging the pinholes we can put a pin through every pair of images; and the average size of a pinhole would then give a fair idea of the probable error of a measure. But the analogy can be made much more exact if, instead of allowing each pin a moderate-sized hole, within which it may stray indifferently, but at the boundary of which it is brought up suddenly,—if instead of this we suppose the two images tied together by a very short elastic string so that when one is relatively displaced there is a force, increasing with the amount of displacement, tending to restore it to coincidence. The process of adjustment by least squares would then be represented mechanically by tying every pair of images, and letting the two diagrams take up their position of equilibrium. Such an analogy is of assistance in visualizing the process through which the plates of the Astrographic Chart will ultimately have to be put in order to get uniformity. In this case one set of strings may be considered to be used for tying together two overlapping plates; and another set for tying the whole series, so connected, down on the chart of known stars which have been observed with meridian instruments.

The University of Oxford is making up its mind to a considerable innovation, by granting degrees for Research. It will shortly be possible for students from other universities, persons of maturer years, or others who from various causes may so desire, to graduate as members of the University without passing the usual examinations, by undertaking some special research at Oxford in a manner at present being considered. The details are not easily settled, and the appearance of the draft statute was merely a signal for numerous amendments which are being eagerly discussed and voted upon. It has already been resolved that the degree so obtained without examination shall not be the ordinary B.A. degree, but that of B.Sc. or B.Lit., according to circumstances. An amendment (moved, but not pressed to a division), that one of the degrees should be "Bachelor of Natural Science," recalls an episode of some fifteen years ago, when the degree of B.N.S. was proposed and decisively rejected. It was remarked on this occasion that no one would care to take a degree which laid them open to being jocularly addressed as a "B. & S."; and it is not improbable that this quip was largely responsible for the decided negative returned to the proposition, the acceptance of which at the time might, for reasons which need not here be recounted, have been of the greatest benefit to the cause of Science in Oxford.

---

Though we are accustomed to the formality of official replies, we should probably agree that a certain waterworks company was carrying formality to excess when it recently answered a piteous appeal from an ice-bound neighbourhood. "With reference to your enquiry &c. &c., I am directed to inform you that the stoppage is believed to be due to the frost." There is a coldness about this reply, which was probably caught from the weather. But there is just the excuse that some correspondents are very easily satisfied; and water companies have probably found this out long ago. Take, for instance, the following extract from a letter I received the other day:—"I ventured to send a design of a telescope and screen with a row of enlarging photographic cameras behind it as a suggestion to the Greenwich Observatory, and *I was pleased* to receive the following reply: 'Sir,—In acknowledging the receipt of your letter the Astronomer Royal requests me to say that he does not consider that the method you suggest for the construction of a novel kind of telescope could be used with advantage.'" The italics are mine; but the rest of the letter makes it plain that this reply is regarded as a testimonial; for the writer was incited by it to make some alterations in his general plan which seemed to him to obviate the trivial and sole objection which had been stated; and having secured in this way that the machine could (in his opinion) be "used with advantage," brought it to my notice. Lest the Astronomer Royal or myself may be suspected of turning a deaf ear to something of value, I will quote one more sentence from the same letter: "The metal work, adjustment of lenses, and the adaptation of glasses and diaphragms, is the speciality of the optician; the minutiæ of construction that of the draughtsman. I cannot infringe on the courtesy of a letter." The exact meaning of the last sentence is as elusive as that of "You're at the right house, but it's the wrong street."

---

In these days of copious illustration it is somewhat strange that the stereoscopic method is so little used for depicting instruments and other objects where it is desirable to give rather more than a diagrammatic view. My attention was drawn to the advantages of the method by Sir Robert Ball, who has used it in representing the fundamental surface in his "theory of screws." It may be objected that a stereoscope is not always at hand; but as, I believe, this instrument can now be purchased for the moderate sum of 1*s*., the objection is not a serious one.

---

Dr. Otto Struve has been settled for some three months at Carlsruhe, and our readers will be glad to learn that the change of climate has done him a great deal of good. He expresses the hope that his friends will visit him at Carlsruhe, which, as he points out, is on the direct route to Switzerland or Italy. His address is 8 Fahnstrasse.

---

It will be a few months before most of us think of holidays and travelling. But perhaps it is not too early to remind American and foreign astronomers who propose to visit England that they may often find their path smoothed by sending word beforehand to the Secretary of the Royal Astronomical Society of their time of arrival, and (as soon as possible) of their address in London or elsewhere. Such visitors are always welcome; but this can be made clear much more easily if their arrival is expected. We shall also be very glad to publish in this journal any such addresses, and other information as to the movements of visitors to Europe, as may be communicated to us for the purpose.

---

In the 'Illustrated London News' for January 5, there is a paragraph in "Our Note-Book" which suggests some reflections on the Astronomer's life. Mr. James Payn is speaking of the late Mr. Robert Louis Stevenson and his choice of a home in Samoa; and writes as follows:—

"'Mine be a cot beside a rill' is an aspiration which even a minor poet would disdain to utter nowadays. This is surely the very coping-stone of the happiness of a calling—to live where we like, be lodged according to our own taste and fancy, and to do our work at home. It is granted to no others to do this save those who tread the flowery paths of letters. In old times they were not so flowery. Addison wrote his 'Campaign' in a garret up three pairs of stars in the Haymarket. At the same time the few men of letters who were enabled by private means to do as they pleased as to the choice of a dwelling-place have shown how much they prized the privilege. Tycho Brahé, the astronomer, built him a magnificent house upon an island, with an observatory, and called it 'the Castle of the Heavens.' Buffon composed in a tower he built in his garden ——: Pope had a good idea of making himself comfortable at home, &c."

It must be questioned, firstly, whether Tycho Brahé was a genuine man of letters; and, secondly, whether an astronomer does not more usually represent quite the other end of the chain in being compelled to live near or in his observatory, which is often scarcely so situated as to please him.

---

HAS anyone the curiosity to collect astronomical allusions and references in contemporary literature? Here are two which might be added to such a collection; the first from Mr. Hall Caine's powerful novel, 'The Manxman,' p. 46:

"This isn't Jupiter, where it is moonlight always."

"Always moonlight in Jubiter is it," said Pete, "my goodness! what coorting there must be there!"

The second is from a story of "Q," in the Christmas number of the 'Pall Mall Budget.' A plantation song is introduced, commencing as follows:—

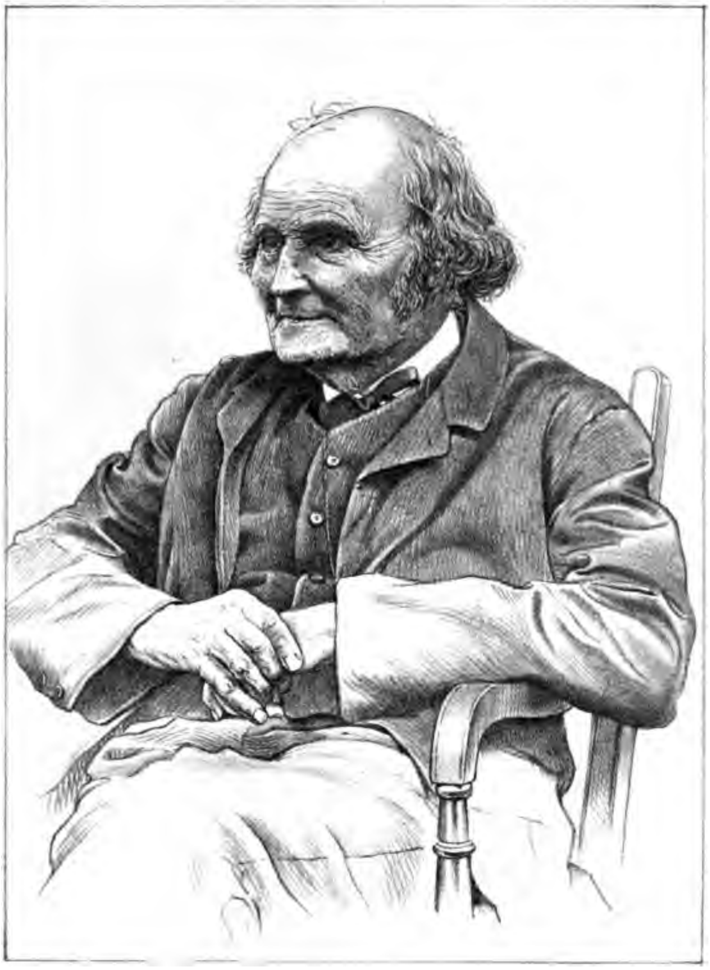
"Oh de lost ell-an'-yard is a huntin fer de morn." ("The lost ell-and-yard is Orion's sword and belt, I may tell you.")

The author very kindly replied to a query on the subject that the lost ell-and-yard is "genuine negro" for Orion's sword and belt, occurring in a corn-shucking song by "Uncle Remus"; and he added, by way of illustration, the following quotation from Daudet's little story, 'Les Étoiles':—

"Un peu plus bas, toujours vers le midi, brille *Jean de Milan*, le flambeau des astres ('Sirius,' of course). Sur cette étoile-là voici ce que les bergers racontent. Il paraît qu'une nuit *Jean de Milan*, avec les *Trois-Rois* et la *Poucinière*, furent invités à la noce d'une étoile de leurs amies. La *Poucinière*, plus pressée, partit, dit-on, la première, et prit le chemin haut..... Les *Trois-Rois* coupèrent plus bas et la rattrapèrent, mais ce paresseux de *Jean de Milan*, qui avait dormi trop tard, resta tout-à-fait derrière, et furieux, pour les arrêter, leur jeta son bâton. C'es pourquoi les *Trois-Rois* s'appellent aussi *le bâton de Jean de Milan*....."

---

HERE, again, are two small astronomical jokes which bear an obvious American impress. A tower is described as being "so high that it has to be lowered every night to let the Moon pass;" and the recently discovered variation of latitude is held responsible for the fact that Alsace and Lorraine are sometimes in France and sometimes in Germany.



ARTHUR CAYLEY

# [illegible]

[illegible]

[illegible]

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 226. APRIL. 1895.

## MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, March 8, 1895.

Dr. A. A. COMMON, F.R.S., *President*, in the Chair.

*Secretaries*: Prof. H. H. TURNER, M.A., B.Sc., and
E. W. MAUNDER.

THE Minutes of the last Meeting were read and confirmed.

*Mr. Maunder.* 102 presents have been received since the date of the last meeting. Amongst those calling for special notice are a work by Prof. Simon Newcomb, 'The Elements of the Four Inner Planets and Fundamental Constants of Astronomy'; the supplement to the American Ephemeris, 1897. A volume of the 'Annals' of Harvard Observatory, containing "Investigations in Astronomical Photography," by Prof. W. H. Pickering; and a valuable 16th-century celestial globe in brass on a bronze tripod-stand, presented by the Earl of Crawford. Three large transparencies of a portion of the Moon, from photographs taken with the Equatorial Coudé of the Paris Observatory by MM. Loewy and Puiseux, have also been received. The three photographs in question are a set of the finest lunar photographs we have yet had the pleasure of seeing.

A vote of thanks was accorded to the donors of the presents.

*Prof. Turner.* We have a large number of papers of interest this evening. Two of the most interesting are by Prof. Barnard, on measures of the diameters of the four bright satellites of Jupiter, and of the Ball and the Ring-system of Saturn, with measures of the diameter of Titan. You may remember that Prof. Barnard has already measured the diameters of the asteroids Ceres, Pallas, and Juno, and has found considerable corrections to previous measurements. With regard to these measures of the system of Saturn the most important part of the paper is the beautiful drawing of the planet, which agrees with the drawing published by Hall some years back in showing remarkably little detail as compared with the drawings made by some observers with instruments a good deal smaller. It may be well for me to read some extracts from the other paper on the measures of the diameter of the four bright satellites of Jupiter. Prof. Barnard says:—The great power and large scale of the 36-inch make it very suitable for measuring small quantities. I began a series of micrometer measures of the diameters of the four bright satellites with the 36-inch, and when bad weather put a stop to the work I collected and reduced the observations. A power of 1000 has been uniformly used. The results of the measures are that the first satellite has a diameter of 1″·05, the second 0″·87, the third 1″·52, and the fourth 1″·43. The probable error of these msasures is represented by 0″·2." The linear diameters corresponding to these measures are respectively 2452, 2045, 3558, and 3345 miles. Prof. Barnard has given a historical account of other measures of these satellites, especially those from eclipses and transits; and he finds that his measures agree very closely with the mean of all these other values. His measures agree very well with measures by Struve, Engelmann, Burnham, and others; and he calls special attention to the measures of Prof. Michelson, by the method of interference. There is a note at the end of the paper about the white equatorial belt on the first satellite, a note on the discovery of which Prof. Barnard sent to this Society last year. He remarks that the discovery was really made in 1890 with the 12-inch equatorial, though not confirmed until last year. It has now been amply verified. A drawing is given in the 'Monthly Notices,' vol. li. page 547, showing all the phenomena observed by Prof. Barnard in 1890.

The Saturn measures were taken up in February and continued until July. The measures have been made with the greatest possible care, and well represent the best results obtained in this direction with the 36-inch equatorial. The observations confirm the previous measures of this planet, and are equally consistent with the work of Prof. Hall at Washington in 1884–7. They show that no change has taken place in Saturn's system since the first systematic measures were made of it. This ought to do away with the fallacy of the supposition that the rings are closing in upon the planet. A series of measures were made of the ring, two nights being devoted to the work. The systematic measures do not show any sensible deviation of the ball from the exact central position of the ring-system. In the observations made in 1894, if any eccentricity exist it must be in the line of sight, and cannot be detected with the micrometer. I don ot think it can be accepted as proved that the eccentricity is real. I shall make a further series of measures to settle this question.

The Encke division was not seen at the time of my drawing, I do not think this marking is a real division like that of Cassini. As it has been seen on both the north and south planes of the ring, it must penetrate through the ring. I have made careful drawings of the planet and the ring. The picture is abnormally devoid of detail when compared with smaller telescope drawings; but I am content to let it remain so.

The interest of the paper throughout is undoubted; but it is of considerable length, and it is difficult to select from so much interesting matter.

*Capt. W. Noble.* In connection with the remark of Prof. Barnard about the Encke division as seen with the 36-inch telescope, I should like to say that I have seen it in one of 4·2 inches aperture for several seconds at a time. I could hold it quite steadily for 4 or 5 seconds, though only in one of the ansæ. I agree that it is not a real division, but probably only a marking. If I could see it with an object-glass of 4·2 inches, it shows how practically certain it is that, with his enormous increase of aperture and power, Prof. Barnard was able to see what he says was visible in the Lick telescope.

*Mr. Knobel.* May I ask what is the date of the observation of the first satellite of Jupiter? because Prof. Barnard mentions the conclusion he comes to is that the axis is perpendicular to the orbit.

*Prof. Turner.* No date is given here beyond that of 1890 Sept. 9, when the white belt and dark poles were first suspected.

*Capt. W. Noble.* I should like to refer again to the subject of Saturn. I am certain that I have seen a shadow of the ball on the ring concave towards the ball instead of convex, as it is drawn. Of course the ball theoretically casts a shadow parallel to its own limb; but I have no doubt whatever that I have seen it curved in the opposite direction. It struck me that it might be the effect of the shadow falling on a concave ring, just as a shadow falling upon a flight of steps will go up in a zigzag. I am absolutely certain I have seen it, although it seems presumptuous to set my small instrument against the 36-inch.

*Dr. Downing.* What power did you use?

*Capt. Noble.* I generally use 255 for Saturn.

*The President.* This is a paper which must be read in detail to appreciate it fully. It represents an immense amount of work. With reference to the drawing of Saturn which has been passed round for inspection, and which Prof. Barnard says is free from the detail shown in smaller telescopes, a point which struck me was the straightness with which Prof. Barnard shows the shadow of the ball on the ring. We have been in the habit of seeing these shadows shown in various ways, and I wondered if Prof. Barnard had alluded to this in his paper; but he does not seem to have made a special study of this point. If it was really so observed, it has a considerable interest. I will ask you to return your thanks to the author of this paper.

*Prof. Turner.* I am afraid I missed the paragraph about the shadow. Prof. Barnard says:—"The shadow of the ball on the ring was uniform in outline and did not show any curvature."

*The President.* That is a very important point. I remember several years ago the question of the form of the shadow was the subject of discussion in this Society. Prof. Barnard has made a reference to Trouvelot's drawing which leads to another important point. The inner edge of the crape ring has often been shown as mottled or serrated. This drawing, so far as I have examined it to-day, shows an almost perfectly defined but faint edge. It is strange that Prof. Barnard, with his magnificent instrument, should not be able to detect some appearances which have been seen with much smaller aperture and power.

*Dr. Spitta.* Prof. Barnard has called attention in his paper to his previous note on the white equatorial band round the first satellite, which he thinks he has discovered. Since that paper was read here, I have made several contrast experiments with balls of different albedo to see how far I could imitate the effect he described. I have found with a certain albedo—that is, with a certain ratio of the reflected power of the ball as compared to a certain depth of colour in the background—I could imitate the effect almost perfectly. I do not say absolutely; but then Prof. Barnard's picture was but a drawing, and he might have been unconsciously biassed while drawing it. The secret of success lies in getting the albedo of the satellite to have a certain ratio to the background, and that might account for the banded effect not being visible with the other satellites. I admit the eye is strangely deceived in this matter, and it is difficult to understand why the shading of the caps does not extend itself all round the ball, but the banded appearance in my experiment was very striking. Of course, when I took a photograph the whole appearance was altered. My only object in making these remarks is that, owing to the deceiving nature of the perceptive faculty of the eye, owing to the effects of contrast, even with so experienced an observer, this banded appearance must be received with great caution before it is accepted as a physical fact.

*The Rev. C. D. P. Davies* read a paper, which was illustrated by a wooden model, on "A suggested Form of Equatorial Mounting for a (modified) Newtonian Reflector." For the form of telescope no novelty was claimed. The first mirror to receive the light, admitted by a suitable opening in the tube, is a flat set at an angle of 45° with the axis of the tube and of the parabolic speculum at the bottom of the tube. The minor axis of the flat is equal to the diameter of the speculum. The light from the flat is returned by the speculum through a hole in the centre of the flat to the eyepiece.

It was suggested that a telescope of this form could be mounted with great advantage by fixing it in the position usually filled by the declination axis, *i.e.* sustained at its centre of gravity across the upper end of the polar axis, having its axis of collimation at right angles to the polar axis. The rotation of the telescope on its axis of collimation would then constitute its setting for declination.

The recommendations claimed for this form of mounting were:—

(1) Great saving of weight and space by the elimination of the counterpoise and of the declination axis.
(2) Increase of stability, with less liability to flexure and tremor.
(3) The telescope can never collide with stand in any position, whether driven by clock or moved by hand.
(4) Possibility of uniform height of eyepiece above observer's standing- or sitting-level.
(5) In the largest telescope every portion of the instrument would be always within reach, without climbing up or down.
(6) No rotation of the tube in its cradle during the most lengthened observation.
(7) Any portion of the visible heavens can be viewed at any time.
(8) Reduction in size of the dome, and therefore a saving of expenses in general.

*The President.* I am unfortunate in having to criticize Mr. Davies' arrangement, because it happens to be a child of my own. So far as regards the optical arrangement, that is much earlier than Brashear, who Mr. Davies suggests originated the plan. I thought that I was first when I proposed such an arrangement as this some years ago; but on looking into a book written in 1845 by Prof. Dick (whose books are well worth reading), I found he describes such an optical combination as that of a Mr. Martin, who had imagined it more than a century before, so that the optical combination is quite 150 years old. I am not quite sure, but I think there are about twenty different and separate combinations of one or more reflecting surfaces which can be used in a telescope. This is one of them; and in thinking for five or six years over the mechanical difficulties of the telescope and not the optical ones, I was led to consider such an arrangement as that which Mr. Davies has now brought before us, and I published a note on a telescope having something of this form in the year 1884. This was about the time Loewy was working on the Coudé form of reflecting telescope. In fact I was a little previous to Loewy, but I did not go so far as he did. I think Mr. Davies is entitled to all the credit due to an original inventor, because I have no doubt he has not had the opportunity of seeing these earlier papers on the subject. It is often my own privilege to think of things which I afterwards find have been thought of before, as an instance of which I have only to mention my plan for the oblique Cassegrain telescope. I have had a letter from Messrs. Fritsch, of Vienna, who claim priority of invention, which, however, I cannot award them. For in a certain periodical published this morning there is a letter in which it is stated that this form of telescope was made in England many years ago, and an account was published in 1825. It only shows that all possibilities in every direction will be thought out sooner or later. The great thing is to put the idea into practice so as to get the best results from it.

*Rev. W. Sidgreaves* read a paper on "the Wilsonian Theory and the Stonyhurst Drawings of Sun-spots." Over 2000 drawings had been examined, and 146 spots had been selected as suitable test cases of real as opposed to an apparent foreshortening of the penumbra, when the spot was near the limb of the Sun. Of these 41 were double observations, the spot having been followed from limb to limb. There were therefore 187 single tests, and of these 140 went against the Wilsonian theory and 47 favoured it.

It was then shown that probably Wilson would not have quoted more than one of these 47 favourable cases, in support of his theory, on account of the shallowness of the cavities which they would imply; but it was admitted that the single exception was one of unexceptionable evidence, although the spot was small.

Two examples were given which showed very pointedly the necessity of having almost a daily record of the behaviour of a spot in transit across the solar disc. One of these showed a clearly dilated penumbra on the limb side, when the spot was near the limb, and a central umbra when the spot was near the middle of the disc; but an intervening drawing showed that the umbra had been extending on the wider side of the penumbra, and had filled up the middle, before the spot had reached the central meridian.

It was observed that some of the test cases went further than to negative Wilson's theory: they showed the contraction of the penumbra on the wrong side; indicating an elevation of the umbra rather than its depression.

Another series of observations seemed also to militate very strongly against the Wilsonian theory; viz., that in a large number of drawings, showing spots of every size within 10″ from one or other limb of the Sun, the umbra was clearly seen along with the penumbra—a phenomenon quite inconsistent with any appreciable excavation.

The notches on the Sun's limb, reported by some observers when a spot was on the limb, were also discussed, and notably the photograph taken at Dehra Dûn on September 17th, 1884. It was shown that these could be explained only by a mountainous form of the umbra shutting out of view the limb of the photosphere.

The general conclusion of the paper was that the Stonyhurst drawings bore witness to occasional elevations and depressions of the umbra, while usually there was no indication of either.

*The Rev. F. Howlett.* It is with the deepest interest I have listened to Father Sidgreaves' paper on this moot point, and a very great pleasure it was to me, after 35 years' observation, to find that at last my theory was gaining ground more and more amongst astronomers. It is a matter of the greatest importance. We shall never by any possibility understand the mystery of the Sun and Sun-spots until we have satisfied ourselves what are the relative proportions and depths of the envelopes of the Sun. I think the only case in which the perspective displacement treated of by Prof. Wilson can hold, would be in the case of a spot in which the proportion or disproportion was very small between the diameter of a spot and its depth. We can quite understand that from the geometry any thickness which the photosphere might possess would tell in the case of a small spot, but would not tell in the case of a larger spot. Now Prof. Wilson, I remember, in the 'Philosophical Transactions,' was hoping intensely for a large spot in which his theory might be put to the test; but it is exactly in such a large spot that no appearance of his theory would be able to manifest itself, but only in a small spot, in which, as I have said, the diameter of the spot would bear only a small proportion to the depth of the photosphere in which it is excavated. As regards that apparent notch which was shown on the screen, I am convinced that it was produced simply by the fact of the degradation of light at the limb of the Sun. The limb always exhibits a degradation of light because of the absorptive power of the solar atmosphere above the photosphere; therefore there was not sufficient actinic power to delineate the spot. If anyone will take the trouble to provide themselves with a fair-sized globe as I have done, he will find that, making a spot as deep as and as large as is consistent with reason, it is not possible to see any indication of a notch whatever—simply a very slight flattening, and that scarcely perceptible, of the solar limb. I explained, in a paper read before the Society, that the conditions under which a notch could possibly appear upon the limb only happen when there is a large and abnormal heaping up of faculous matter north and south of the spot, and not at the same time east and west—if it were at the same time east and west it would neutralize the effect of the notch which might be produced if there were faculæ piled up only on the north or south sides. I hope the matter will continue to be discussed.

It would be extremely satisfactory to me to find, after so many years of labour, that this important point was really satisfactorily settled amongst astronomers.

*Prof. Turner.* I quite agree with Mr. Howlett that this is an important question to settle. Personally I should like to express a hope that future investigations may contain a few more figures. We have here a long paper and not a single table. It does seem to me that to settle a nice question of this kind the medium must be measures and figures. We want to know what are the facts tabulated for and against. For instance, Father Sidgreaves says, at the beginning of his paper, that the Stonyhurst drawings extend over less than half a year and are made to scale. If they are made to scale they are convertible into figures. There must be a certain foreshortening of the part of the spot near the limb in excess of that further away from it. It may be small: but if the spot were absolutely flat, the part nearest the limb would be foreshortened more than the part away from the limb. We ought to have measures of this foreshortening and so find whether the spot stands for or against Wilson's hypothesis. In fact we wan micrometric measures of spots in the place of marks for or against It should not be difficult to collect some facts of this kind; bu if we go on talking and not measuring, we shall not get muc further.

*Rev. F. Howlett.* I have paid much attention to accurat measurement of spots. In many cases I have specified th breadth of the penumbra on either side in seconds of arc, and i my eight volumes of drawings there will be found an index to eac volume which gives the numbers of spots which favour Wilson' theory and those which are evidence to the contrary respectively.

*Mr. Lynn.* Might I ask Mr. Howlett how he explains this:— Prof. Wilson says he saw this phenomenon in a *large* spot, an now Mr. Howlett says that it could not have been seen in such spot. I suppose he does not call Prof. Wilson's good faith i question.

*Rev. F. Howlett.* I do not call in question Prof. Wilson's goo faith, but I do call in question the capabilities of the instrumen he employed; and I think the fact that he appeared to desire t see a large spot in order to corroborate or disprove his theor proves that he was not really capable of giving a really reliabl verdict upon the question at issue, because the larger the spot th more certainly you will fail to see the least distortion betwee the sides of the umbra. I have never witnessed the phenomen once.

*Rev. A. L. Cortie.* There can be, I think, but one opinion as t the value of Father Sidgreaves' paper, and that is that it is a ver important contribution to a discussion which has now been proceding for more than a hundred years. But I quite agree wit Professor Turner that the value of the paper would be greatl enhanced if there were tables appended to it, and I know tha the materials for such tables exist at Stonyhurst. The tables, would suggest, should contain besides the dates of observation o the spots which were given as evidence either for or against th Wilsonian hypothesis, their positions, the period of their life-history, and some information as to whether they were surrounde by or were free of faculæ when near the solar limb. The date would be most useful for comparison with the indexes in Mr Howlett's volumes of drawings, with the admirable Greenwic records, and with the observations of other observers. Wit reference to the date in the life-history of the spot when it told fo or against the Wilsonian hypothesis, this I regard as a point mos important in its bearings on the theory of sun-spot nature Father Secchi imagined a sun-spot to be but a metallic prominenc seen projected on the brilliant photospheric clouds, and finall sinking into them. Hence it would follow that a sun-spot shoul be sometimes above, sometimes level with, and finally below th photosphere. Thus we might be able to reconcile Wilson and hi adversaries. With regard to the point regarding the accompany ing faculæ, this too is important, for Secchi holds, and holds rightly, that oftentimes when a spot is near the limb, projecting faculæ form a sort of pad or cushion near the spot, and so mask the cavernous appearance. In this discussion we must not forget that Secchi, who was a first-class solar observer, made with Tacchini a careful study of these points, with the result of confirming in the main Wilson's hypothesis. Warren de la Rue, Balfour Stewart, and Loewy also discussed the question in their "Researches on Solar Physics," with the result that of 605 spots measured 86·4 per cent. were for, and 13·6 against the hypothesis. But they seem to have taken every and any spot observed at the limb, without due regard to its life-history. However, Warren de la Rue suggested viewing two pictures of a spot, so says Secchi, taken at a day's interval, by means of the stereoscope. The result is that the spots appear to be cavernous.

I should like to add a few words with regard to Mr. Howlett's drawings, so generously presented to our library. I have looked through a great number of them, and I have made a detailed study of one year. As a collection of enlarged drawings of spots extending over a long period, they are unique, and probably never will be surpassed. But, at least for the year which I have studied, I cannot admit their evidence against Wilson. In this year eleven instances are indexed as decidedly against Wilson. Of these eleven instances, I should only allow one case as probably against Wilson, and that is the most southern of the three spots which were near the preceding limb on Oct. 17, 1883. I admit that if these quoted instances be studied simply at the limb they tell for the most part against Wilson. But if we are to admit no spot in favour of Wilson which had not the umbra central to the penumbra, and which was undergoing change, then neither can we admit their witness against him. With regard to Mr. Howlett's instances in 1883, of two, the life-histories cannot be followed from the drawings, and of the remaining nine cases, the drawings themselves show, except in the case of one spot of one group of three, that the spots were undergoing active changes. In fact one instance is, in my opinion, rather for than against Wilson.

*Capt. John Steele.* There appears to be another side of the question as to the cause from which these spots arise. Is the Sun a solid body or is it not so? I argue that it is a solid body and that there is no more heat in the Sun than in the Earth, and I have endeavoured to prove that by demonstration. If it is a solid body we may have projections and we may have caverns. There may be cavities in the Sun and there may be projections from the Sun.

*Rev. W. Sidgreaves*, in reply, remarked that all were agreed upon the necessity of knowing the history of a spot before accepting its appearance at the limb as evidence for or against the Wilsonian theory; and with reference to Professor Turner's comment upon the absence of figures to show the measured differences of penumbral widths, that this addition to his paper would necessarily have delayed its reading one or more months.

*The President.* We have had a very interesting discussion, and for the moment it appears that Prof. Wilson's theory is overthrown; but I think we should remember that Prof. Wilson's theory was based on observations, and as far as I have looked at the Sun, I must say that at a first or even a second glance, there is certainly an impression that Prof. Wilson's theory must be the true one. He certainly based his theory on few observations, perhaps if he had had the opportunity of making the very extended series of observations Mr. Howlett and Father Sidgreaves have, he might have modified his theory; but his hypothesis was founded on observations which I believe all who look at the Sun in a cursory way would confirm.

*Prof. Turner* then introduced *Mr. W. E. Cooke's* paper on "An Apparatus for mechanically calculating Star-corrections," and illustrated it by means of the instrument described by Prof. Turner in 'Monthly Notices,' vol. liv. p. 367, to which Mr. Cooke now suggested two very essential improvements.

*Dr. Downing.* Such apparatus as this just described, for the purpose of minimizing the labour of computation, is in many cases highly desirable. In the 'Nautical Almanac' Office we use a machine for the purpose of computing star-corrections; but in our case the circumstances are rather different to those which obtain in a fixed observatory, for in the 'Nautical Almanac' Office the star-corrections are required for each star at ten-day intervals. The apparatus we use was designed by Mr. Hudson, and is in fact a multiplying machine, which effects the multiplication of the star-constant by the day number for all the required days of the year at one setting of the instrument, and is found to answer its purpose admirably. We have lately added so many stars to the list given in the Almanac, that some method of shortening the work was imperatively required.

Votes of thanks were accorded to Mr. Cooke and Prof. Turner.

*The President.* There are several other papers of interest, but which we have not time to discuss now. One, a paper by Mr. Maw, giving his measures of 99 double stars made between the years 1892 and 1894, is perhaps more fitted to be perused when printed in the 'Memoirs' than to be read here. I will just mention the subject of another paper preparatory to its discussion at the next meeting. This is by Mr. Dennis Taylor, and adduces negative evidence for the absence of seas on Mars. The author considers the matter from an optician's point of view. If there are seas on Mars, the planet forms a large convex speculum, and, acting as such, should reflect the sun-light falling upon it, and this reflection should be seen as a second magnitude star. No one, so far as we know, has ever seen such an effect. I remember some years ago there was a discussion in this Society on specular reflection from Venus; and Mr. Brett, after explaining that he had seen such reflection from Venus, stated that he had examined

Mars and Mercury, but did not see a similar appearance on these planets. This is an interesting subject, and I mention it now that Fellows may be prepared for its discussion next month.

The following papers were announced and partly read:—

*E. E. Barnard.* "Micrometer Measures of the Diameters of the Satellites of Jupiter."

*W. F. Gale.* "The Transit of Mercury, 1894 November 10."

*R. T. A. Innes.* "A List of probably new Double Stars."

*J. P. Thompson.* "The Transit of Mercury, 1894 November 10."

*E. E. Barnard.* "Micrometrical Measures of the Ball and Ring-System of Saturn, and Measures of the Diameter of Titan."

*W. H. Maw.* "Double Star Measures, 1892–94."

*J. Tebbutt.* "Double Star Measures at Windsor, N. S. Wales, in 1894."

*Lt.-Col. Markwick.* "Notes on the Variable Stars X and W Sagittarii."

*Rev. C. D. P. Davies.* "Note on a suggested Form of Equatorial Mounting for a (modified). Newtonian Reflector."

*W. T. Lynn.* "On the Proper Motion of B.A.C. 793, and Cephei 24 (Hev.)."

*Rev. W. Sidgreaves.* "The Wilsonian Theory and the Stonyhurst Drawings of Sun-spots."

*Royal Observatory, Greenwich.* "Observations of Encke's Comet."

*W. E. Cooke.* "An Apparatus for mechanically calculating Star-corrections."

*Prof. H. H. Turner.* Note on the above paper.

*H. Dennis Taylor.* "A Negative Optical Proof of the Absence Seas in Mars."

*E. J. Stone.* "A Systematic Comparison between the Places of Stars given in the Cape Catalogue for 1880 and the Radcliffe Catalogue for 1890."

*E. J. Stone.* "On the Mean Places of eight southern close Polar Stars."

*T. J. Moore.* "Observations of the Vertical Diameter of the Planet Jupiter."

*Percival Lowell.* "Determinations of the Longitude and Latitude of Points upon the Disc of the Planet Mars."

The following gentlemen were elected Fellows of the Society:—

*George Denton Hirst*, Sydney, New South Wales; *Samuel V. Hoffman*, 1 Chelsea Square, New York City, U.S.A.; *Henry T. C. Knox*, F.R.G.S., Lieut. (late R.N.), 17 Upper Montagu Street, W.; *E. F. J. Love*, M.A., Melbourne University, Australia; *Rev. Daniel Higham Sparling*, B.A., Biddulph Moor Rectory, Congleton.

The following Candidates were proposed for election as Fellows of the Society:—

*Andrew Russell Forsyth*, F.R.S., Sadlerian Professor of Pure Mathematics, Cambridge (proposed by Prof. Turner).

*John Willoughby Meares*, Electrical Engineer, Clive Hall, Shrewsbury (proposed by Arthur Mee).

*William Willett, jun.*, The Cedars, Chislehurst Common, Kent, and 2 Sloane Gardens, S.W. (proposed by W. H. Thornthwaite).

---

## BRITISH ASTRONOMICAL ASSOCIATION.

The fourth ordinary meeting of the fifth session of the British Astronomical Association was held at University College, Gower Street, on Wednesday, 27th February, Mr. E. W. Maunder, President, in the chair.

*Mr. T. G. Elger* (Director of the Lunar Section) contributed a paper giving a number of suggestions for observing the Total Eclipse of the Moon on the 10th March. *Mr. A. C. D. Crommelin*, also read a paper on the same eclipse, and on the partial Solar Eclipse of the same month, pointing out that, contrary to the statement in some of the almanacs, it would be visible at Greenwich, beginning there at $9^h 56^m$, and ending at $10^h 23^m$.

*Mr. Edwin Holmes* read a paper on "Points about Reflecting Telescopes." Speaking from considerable experience with reflecting telescopes up to 12½ in., he thought that the instruction books of various makers did not lay enough stress upon getting the mechanical adjustments as perfect as possible before attacking the optical ones. For neighbourhoods where there was much traffic, strong wood tripod stands would be found preferable to iron stands, either resting on or embedded in the ground. He also strongly advised wood tubes as preferable to iron ones, and was of opinion that the old method of mounting the flat on a single arm was preferable to the modern three thin strips of steel. His remarks had reference only to altazimuth reflectors, not equatorials.

*Mr. A. Hilger* agreed with Mr. Holmes as to the advantages of wooden tubes over iron ones.

*Mr. Josh. Lunt* remarked that his experience was to the same effect.

In reply to Mr. Baly, Mr. Holmes said that he had had no experience with a reflector in an observatory.

*Mr. A. J. S. Adams* read a paper on "The Connection between Variations of Terrestrial Magnetism and Solar-Surface Disturbances." He referred to the Stonyhurst reports as apparently negativing the idea of a connection, but urged that in view of the striking accord in the case of the greater spot groups, the apparent want of agreement was unreal and should be taken as a merely negative result.

*Rev. A. L. Cortie* remarked that sun-spots were only one class of solar phenomena; faculæ and prominences were equally manifestations of solar activity; hence to simply compare magnetic storms with sun-spots was to take insufficient cognizance of other equally important solar phenomena. Lord Kelvin had mathematically demonstrated that solar outbursts and magnetic storms could not be connected together in the relation of cause and effect, but it was not impossible that they were correlated effects of some common cause. Still it seemed clear that spots of a certain definite type were closely related to magnetic paroxysms.

*The President* said he could fully confirm the conclusions of the Stonyhurst observers. He had compared the sun-spots and the magnetic records of the last solar cycle and found that while in the case of three or four of the greatest sun-spots magnetic disturbances were synchronous—precisely synchronous—no true connection could be established between spots of a lower order and smaller magnetic disturbances. He thought, with Father Cortie, that possibly the sun-spots were not the most truly significant of solar phenomena.

A number of lantern slides were then shown on the screen, including a selection from the drawings of Mars, lent by Rev. E. Ledger, the Gresham Lecturer on Astronomy. The President drew particular attention to a set of drawings of the planet by Mr. Green, made in Madeira in 1877, which he thought were still the most truthful representations that had ever been published of the planet.

Papers on "The Observation of the Planet Jupiter," by Rev. W. R. Waugh, and on "Development of the Plates of the International Astrographic Chart," by Mr. G. S. Criswick, were then read by Mr. Petrie.

---

## ROYAL METEOROLOGICAL SOCIETY.

At the Meeting of this Society on Wednesday evening, the 20th instant, Mr. W. N. Shaw, F.R.S., delivered a lecture on "The Motion of Clouds considered with reference to their Mode of Formation," which was illustrated by experiments.

The question proposed for consideration was how far the apparent motion of cloud was a satisfactory indication of the motion of the air in which the cloud is formed. The mountain cloud cap was cited as an instance of a stationary cloud formed in air moving sometimes with great rapidity; ground fog, thunder-clouds, and cumulus clouds were also referred to in this connection.

The two causes of formation of cloud were next considered, viz., (1) the mixing of masses of air at different temperatures, and (2) the dynamical cooling of air by the reduction of its pressure without supplying heat from the outside. The two methods of formation were illustrated by experiments.

A sketch of the supposed motion of air near the centre of a cyclone showed the probability of the clouds formed by the mixing of air being carried along with the air after they were formed, while when cloud is being formed by expansion circumstances connected with the formation of drops of water on the nuclei to be found in the air, and the maintenance of the particles in a state of suspension, make it probable that the apparent motion of such a cloud is a bad indication of the motion of the air.

After describing some special cases, Mr. Shaw referred to the meteorological effects of the thermal disturbance which must be introduced by the condensation of water vapour, and he attributed the violent atmospheric disturbances accompanying tropical rains to this cause.

The difference in the character of nuclei for the deposit of water drops was also pointed out and illustrated by the exhibition of coloured halos formed under special conditions when the drops were sufficiently uniform in size.

---

## *A Note on Stellar Parallax, with a List of Mean Parallaxes.*

Some years since, having collected into a list all stars whose parallax had been measured and arranged them in the various regulation ways, I deduced results rather at variance with the generally received ideas. These variations I attributed to the fact that, like myself, each tabulator had selected what he considered the best parallax for the individual stars, which were not the same as my selected values, and so I let the matter drop. There was, however, one arrangement which showed some promise, and recently I have given some attention to it, and present it here with other notes, not so much for its intrinsic worth but because I think it full of suggestions.

Starting anew, it seemed best not to select any particular values of the parallaxes, but to work on the hypothesis that the mean of all determinations was as likely to be as near the truth as any individual determination. By adopting this course one is also freed from any prejudice.

The material is derived from the "Astronomical Observations made at the University Observatory, Oxford.—No. IV. Researches in Stellar Parallax by the aid of Photography, 1892," with, of course, the results since published to make it complete.

The headings in the table need no explanation, except perhaps the last, in which is given the velocity of the star in miles per second, derived by dividing the proper motion by the parallax, and reducing to miles per second. It is actual velocity across the line of sight without reference to direction.

## TABLE I.

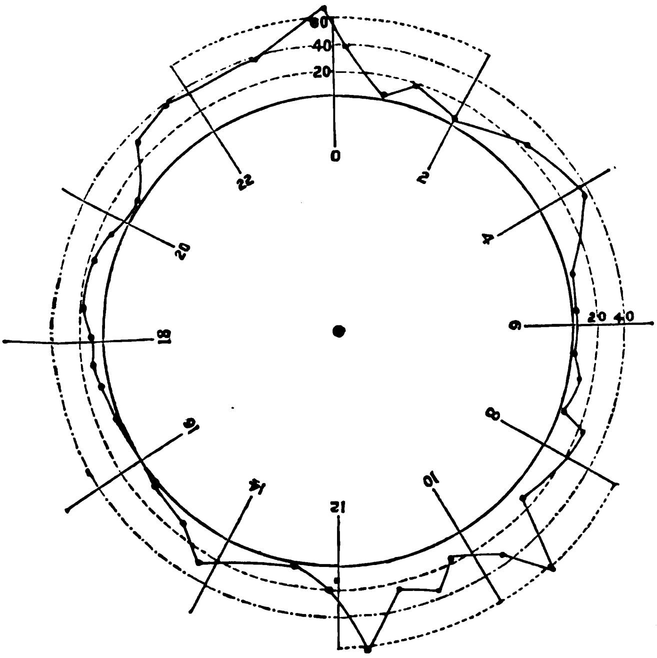
### Mean Parallaxes, &c., of Stars.

| Star's Name. | R.A | | Dec. | Mag. | P.M. | Parallax. | Velocity. |
|---|---|---|---|---|---|---|---|
| | h | m | ° | | ″ | ″ | |
| α Andromedæ | 0 | 3 | +20·5 | 2·1 | 0·17 | 0·059 | 8·3 |
| β Cassiopeiæ | 0 | 4 | +58·6 | 2·3 | 0·55 | ·154 | 10·5 |
| Groombridge 34 | 0 | 12 | +43·4 | 7·9 | 2·80 | ·292 | 28·1 |
| ζ Toucanæ | 0 | 15 | −65·5 | 4·1 | 2·05 | ·057 | 105·5 |
| α Cassiopeiæ | 0 | 34 | +56·0 | 2·1 | 0·05 | ·036 | 4·1 |
| η " | 0 | 43 | +57·2 | 3·4 | 1·20 | ·285 | 12·0 |
| γ " | 0 | 50 | +60·1 | 2·2 | 0·02 | ·050 | 1·2 |
| μ " | 1 | 1 | +54·4 | 5·2 | 3·75 | ·180 | 60·9 |
| β Andromedæ | 1 | 4 | +35·1 | 2·2 | 0·19 | ·074 | 7·5 |
| θ Cassiopeiæ | 1 | 5 | +54·6 | 4·4 | 0·31 | ·232 | 3·9 |
| Polaris | 1 | 20 | +88·7 | 2·1 | 0·05 | ·082 | 1·8 |
| α Arietis | 2 | 1 | +23·0 | 2·1 | 0·23 | ·080 | 8·4 |
| β Persei | 3 | 1 | +40·5 | {2·3<br>3·5} | 0·02 | ·059 | 0·9 |
| ε Eridani | 3 | 16 | −43·5 | 4·4 | 3·03 | ·14 | 63·4 |
| α Persei | 3 | 17 | +49·5 | 1·9 | 0·05 | ·087 | 1·7 |
| Piazzi III. 242 | 4 | 0 | +37·8 | 7·4 | 0·25 | ·016 | 45·7 |
| $o^2$ Eridani | 4 | 10 | − 7·8 | 4·5 | 4·05 | ·195 | 60·9 |
| Aldebaran | 4 | 30 | +16·3 | 1·1 | 0·19 | ·101 | 5·5 |
| Capella | 5 | 9 | +45·9 | 0·1 | 0·44 | ·181 | 7·1 |
| Rigel | 5 | 10 | − 8·3 | −0·1 | 0·02 | ·095 | 0·6 |
| β Tauri | 5 | 20 | +28·5 | 1·8 | 0·18 | ·063 | 8·5 |
| α Orionis | 5 | 49 | + 7·4 | 0·0 | 0·02 | ·022 | 2·7 |
| South 503 | 5 | 50 | +13·9 | 7·0 | 0·65 | ·001 | 1904·5 |
| β Aurigæ | 5 | 51 | +44·9 | 1·9 | 0·07 | ·062 | 3·3 |
| α Argûs | 6 | 22 | −52·6 | 0·4 | 0·00 | ·03 | 0·0 |
| $\chi^5$ Aurigæ | 6 | 34 | +28·4 | 5·6 | 0·15 | ·116 | 3·0 |
| Sirius | 6 | 40 | −16·6 | −1·9 | 1·31 | ·336 | 11·4 |
| Cephei 51 | 6 | 51 | +87·2 | 5·4 | 0·06 | ·027 | 6·5 |
| Castor | 7 | 28 | +32·1 | 1·5 | 0·21 | ·198 | 3·1 |
| Procyon | 7 | 34 | + 5·5 | −0·5 | 1·25 | ·322 | 14·3 |
| Pollux | 7 | 39 | +28·3 | 1·4 | 0·63 | ·057 | 32·5 |
| ι Ursæ Maj. | 8 | 52 | +48·2 | 3·2 | 0·50 | ·130 | 11·3 |
| 10 " " | 8 | 53 | +42·2 | 4·2 | 0·50 | ·020 | 7·3 |
| Σ 1321 | 9 | 6 | +53·2 | 7·4 | 1·69 | ·074 | 66·9 |
| θ Ursæ Maj. | 9 | 25 | +52·2 | 3·1 | 1·11 | ·052 | 62·7 |
| B.B. VII. 85 | 9 | 37 | +43·2 | 8·1 | 0·79 | ·064 | 35·4 |
| 20 Leo Min. | 9 | 55 | +32·5 | 6·0 | 0·69 | ·062 | 32·5 |
| Regulus | 10 | 3 | +12·5 | 1·2 | 0·26 | ·089 | 8·6 |
| Groombridge 1618. | 10 | 5 | +50·0 | 6·7 | 1·43 | ·275 | 15·1 |
| B.B. VII. 94 | 10 | 22 | +49·3 | 6·3 | 0·89 | ·101 | 25·6 |
| B.B. VII. 95 | 10 | 27 | +49·7 | 7·4 | 0·27 | ·038 | 20·6 |
| β Ursæ Maj. | 10 | 27 | +55·9 | 2·2 | 0·08 | ·087 | 2·9 |
| α " " | 10 | 27 | +62·3 | 1·9 | 0·14 | ·047 | 8·8 |
| Lalande 21185 | 10 | 58 | +36·7 | 6·8 | 4·75 | ·465 | 29·9 |
| Lalande 21258 | 11 | 0 | +44·1 | 8·5 | 4·40 | ·230 | 55·9 |
| Σ 1516 | 11 | 8 | +74·0 | 7·0 | 0·42 | ·194 | 6·4 |
| O.A. 11677 | 11 | 15 | +66·5 | 9·0 | 3·04 | ·203 | 44·0 |
| B.B. VII. 110 | 11 | 33 | +45·7 | 6·7 | 0·64 | ·030 | 62·4 |
| B.B. VII. 111 | 11 | 40 | +48·3 | 8·0 | 0·67 | ·016 | 122·8 |
| β Leonis | 11 | 43 | +15·2 | 2·1 | 0·52 | ·029 | 52·7 |

TABLE I. (*con.*).

| Star's Name. | R.A. | Dec. | Mag. | P.M. | Parallax. | V |
|---|---|---|---|---|---|---|
| | h m | ° | | ″ | ″ | |
| Groombridge 1830 . | 11 47 | +38·5 | 6·5 | 7·05 | ·227 | |
| γ Ursæ Maj. ......... | 11 48 | +54·3 | 2·3 | 0·09 | ·100 | |
| B.B. VII. 119 ...... | 12 4 | +40·8 | 7·3 | 0·33 | ·056 | |
| ε Ursæ Maj. ......... | 12 49 | +56·5 | 1·8 | 0·10 | ·081 | |
| β Centauri ............ | 13 56 | −59·9 | 1·2 | 0·09 | ·322 | |
| Arcturus ............ | 14 10 | +19·7 | 0·3 | 2·28 | ·102 | |
| $a^1$ Centauri ......... | 14 32 | −60·4 | 0·7 | 3·67 | ·815 | |
| $a^2$ Centauri ......... | 14 32 | −60·4 | 0·7 | 3·67 | ·815 | |
| β Ursæ Min. ......... | 14 51 | +74·6 | 2·3 | ·03 | ·064 | |
| η Herculis ............ | 16 39 | +39·1 | 3·6 | ·08 | ·40 | |
| a „ ......... | 17 10 | +14·5 | 3·0 | ·04 | ·050 | |
| δ „ ......... | 17 11 | +25·0 | 3·0 | ·16 | ·061 | |
| π „ ......... | 17 11 | +36·9 | 3·6 | ·04 | ·11 | |
| $\nu^1$ Draconis ......... | 17 30 | +55·3 | 4·8 | ·16 | ·32 | |
| $\nu^2$ „ ......... | 17 30 | +55·3 | 4·8 | ·16 | ·28 | |
| O.A. 17415–6 ...... | 17 34 | +68·5 | 9·0 | 1·27 | ·183 | |
| γ Draconis......... .. | 17 54 | +51·5 | 2·4 | 0·04 | ·064 | |
| 70 Ophiuchi ......... | 18 0 | + 2·5 | 4·4 | 1·13 | ·218 | |
| a Lyræ ............... | 18 33 | +38·7 | −0·1 | 0·36 | ·092 | |
| δ Ursæ Min. ......... | 18 6 | +86·6 | 4·5 | ·04 | ·118 | |
| Σ 2398 ............... | 18 42 | +59·5 | 8·2 | ·24 | ·356 | |
| 6 B Cygni ............ | 19 9 | +49·6 | 6·6 | ·64 | ·303 | |
| σ Draconis............ | 19 33 | +69·4 | 4·8 | 1·84 | ·246 | |
| a Aquilæ ............ | 19 46 | + 8·6 | 1·0 | 0·65 | ·207 | |
| γ Cygni ............... | 20 18 | +39·7 | 2·3 | ·02 | ·102 | |
| $61^1$ Cygni ............ | 21 2 | +38·2 | 5·0 | 5·16 | ·394 | |
| $61^2$ Cygni ............ | 21 2 | +38·2 | 5·0 | 5·16 | ·445 | |
| a Cephei............... | 21 8 | +29·8 | 2·6 | 0·16 | ·061 | |
| δ Equulei ............ | 21 9 | + 9·6 | 4·0 | 0·30 | ·017 | |
| ε Pegasi ............... | 21 39 | + 9·4 | 2·4 | 0·10 | ·081 | |
| ε Indi .................. | 21 55 | −57·2 | 5·2 | 4·60 | ·200 | |
| a Pegasi ............ | 22 59 | +14·6 | 2·3 | 0·06 | ·082 | |
| Lacaille 9352 ...... | 22 59 | −36·5 | 7·5 | 6·96 | ·285 | |
| Bradley 3077 ...... | 23 8 | +56·4 | 5·5 | 2·09 | ·176 | |
| 85 Pegasi ............ | 23 57 | +26·5 | 5·8 | 1·29 | ·058 | |

Now instead of plotting down the parallaxes as ordinates the R.A. as abscissæ, the velocities were used as ordinates. I annexed diagram this system has been modified to give a b idea of its bearing. The right ascensions have been m round the circle and the velocities dotted on the normals. Fur to simplify the figure, in place of the velocity of each star mean velocity for every half-hour has been used. This re the range, but I am sure that the resulting curve is not exagger



Arranging the velocities in groups of four hours each, and taking the mean R.A.'s and velocities in each group, the results are shown in the following table:—

TABLE II.

| Group. | No. of stars. | Mean R.A. | Vel. | Group. | No. of stars. | Mean R.A. | Vel. |
|---|---|---|---|---|---|---|---|
| h h | | h m | | h h | | h m | |
| 9–13 | 18 | 10 52 | 36·5 | 21–1 | 21 | 23 9 | 33·9 |
| 13–17 | 10 | 14 57 | 15·8 | 1–5 | 6 | 2 46 | 20·0 |
| 17–21 | 15 | 18 16 | 8·1 | 5–9 | 15 | 6 43 | 8·0 |

An excess of 27 miles per second in the groups $9^h$–$13^h$ and $21^h$–$1^h$ over the groups $17^h$–$21^h$ and $5^h$–$9^h$.

Now arranging the stars in order of magnitude, and omitting $\alpha^1$ and $\alpha^2$ Centauri, because their parallaxes being so large these would give a false mean value to the group containing them, and South 503, because its velocity would similarly give an erroneous impression, the following table results:—

TABLE III.

| Mean magnitude. | Mean P.M. | Mean parallax. | Mean velocity. | No. of stars. |
|---|---|---|---|---|
| | ″ | ″ | miles. | |
| −0·66 | 0·74 | 0·211 | 9·4 | 4 |
| +0·20 | 0·69 | ·084 | 18·9 | 4 |
| 1·18 | 0·38 | ·155 | 11·3 | 5 |
| 1·80 | 0·12 | ·098 | 4·0 | 5 |
| 2·08 | 0·13 | ·066 | 6·3 | 5 |
| 2·20 | 0·28 | ·077 | 15·0 | 5 |
| 2·30 | 0·04 | ·081 | 1·7 | 5 |
| 2·70 | 0·10 | ·063 | 4·6 | 5 |
| 3·38 | 0·58 | ·179 | 18·6 | 5 |
| 4·24 | 1·24 | ·150 | 48·0 | 5 |
| 4·82 | 2·60 | ·260 | 31·3 | 10 |
| 6·01 | 1·55 | ·157 | 35·0 | 10 |
| 7·26 | 2·19 | ·161 | 36·6 | 8 |
| 8·40 | 2·20 | ·194 | 47·7 | 7 |

This table suggests the following conclusions:—

(1) Leaving out a few of the brightest stars, the parallaxes are constant down to 2·70 magnitude.

(2) After 2·70 mag. is reached the parallaxes are doubled and remain practically constant to 8·40 mag.

(3) Up to the 3rd magnitude the velocities are very small, averaging about 9 miles per second, while after the 3rd mag. the velocity is 38 miles per second.

Hence we may fairly deduce:—

(1) That there are a few stars (about 8) of exceptional brilliancy in our immediate neighbourhood, and scattered about amongst these a number of small stars (at present about 40 are known).

(2) Stars of mag. 1·0 to 3·0 are as a class far outside this inner space, and have very small velocities.

(3) The small stars here dealt with have apparently large velocities across the line of sight.

These results show that the generally received idea, that parallaxes are to be sought for in stars with a large Proper Motion, is correct, and we may add that this holds good no matter what may be the star's magnitude.

Speaking generally, the proper motions of these small stars are exceptionally large (2″ to 4″), but the large velocities seem to indicate, by the large range, that only a small proportion of this class have been observed, and that small stars whose proper motion is 0″·5 are legitimate objects for "Parallax hunting." It may be, however, that these small stars really have larger velocities. In any case something should be known of what one might call the history of small comparison stars, and in instances where a negative parallax has been obtained it would be well to attack the comparison stars. There are many other points readily seen from Table III., and I suggest that this table is worthy of careful study.

THOMAS LEWIS.

---

## *Selenographical Notes.*

LUNAR RIVER-BEDS AND VARIABLE SPOTS. PROF. W. H. PICKERING'S OBSERVATIONS AT AREQUIPA.—Since their discovery by Schröter nearly a century ago, the enigmatical cracks and furrows, termed rills or clefts, found so frequently in various parts of the Moon's surface, have perhaps excited the interest and curiosity of observers more than any other lunar formations. A few of these features are such comparatively coarse grooves that they can be seen in telescopes as small as 2-in. aperture, others consist of delicate striæ which demand the most perfect atmospheric and instrumental conditions to be glimpsed at all; while between these extremes are very many that can be followed at suitable times in any good telescope of moderate size. There are, in short, rills and rills, differing not only in size and character, but which probably owe their origin to different causes; some with flanks, like those of the cañons of the Colorado, descending nearly perpendicularly to unknown depths below the surface, others running through valleys with gently-sloping sides, resembling valleys of erosion. Among other fanciful views respecting them, Gruithuisen believed that some represent the dried-up beds of immense rivers, Schröter's valley, better known as the great winding cleft near Herodotus, being the most notable example of such. After being so long discredited by selenographers, it is not a little remarkable that this idea of Gruithuisen has been revived by Prof. W. H. Pickering in his visual and photographic observations of the Lunar Surface which appear in the recently published 'Annals of the Astronomical Observatory of Harvard College,' vol. xxxii. part 1, together with other most interesting and important discoveries relating to variable spots, and what he terms "river-beds," made with the Boyden achromatic of 13 in. aperture, during his stay at Arequipa, Peru.

Believing, for reasons assigned in this volume, that the Moon possesses an atmosphere of a density at its surface equal to the Earth's at an altitude of about 40 miles, that water once existed on the Moon in small quantities, and that probably it has not yet entirely disappeared, Prof Pickering devoted his attention to the details of many lunar rills with a view to elucidate these questions. He finds among certain minute types of these objects several that differ in many important respects from those which are ordinarily familiar to observers. He calls them "river-beds."

They present the following peculiarities:—"(1) They are always wider at one end than at the other. (2) The wide end always terminates in a pear-shaped craterlet. (3) Their length is composed almost entirely of curves of very short radius, giving them a zigzag, winding appearance, exactly resembling a terrestrial river drawn upon a map. (4) One end is nearly always perceptibly higher than the other." But he points out an important difference between them and a terrestrial river in the fact that their apparent mouth is always higher than the source, and adds: "What this means, is, of course, that, if formed by the action of water, as seems from their appearance probable, the lake flowed into the river and not the river into the lake."

As just stated, these river-beds, observed by Prof. Pickering, belong to a very minute class, with two exceptions; one, originating east of Mt. Hadley δ, and following a winding course towards the north, and the other, the celebrated winding cleft associated with Herodotus, which is thus described:—"This valley takes its exit from a long pear-shaped craterlet in the vicinity of Herodotus, and flows first north, then east, and later south. At its exit it is three miles in breadth, and is about one hundred and twenty miles in length. Its apparent dimensions in a direction at right angles to the limb, near which it is situated, are considerably foreshortened. When near the terminator, it is seen that this river-bed took its origin in the crater of Herodotus itself, but that its exit was closed by a subsequent eruption of black material, nearly choking up the original valley. This cannot be seen when the sun rises higher, and the valley at present terminates at the pear-shaped crater, above mentioned. This does not not seem to have been noticed by Neison ('The Moon,' p. 272), who connects it with Herodotus itself, or, as he states it, 'It then extends to the foot of the wall of Herodotus, passes through in a gap, and ends in a broad mouth in the interior.' No such gap is in existence at present, nor probably has it been for many thousands of years." I have more than once pointed out, in these pages and elsewhere, the difficulty of seeing the embouchure of this valley as shown in the maps, and several drawings have been made exhibiting a dusky area extending for some miles north of Herodotus, through which only very doubtful indications of its existence are traceable even under the most favourable conditions, though the rest of the valley is everywhere perfectly distinct. The best phase for observing this appearance is when the E. long. of the morning terminator is about 63°. To return, however, to Prof. Pickering's observations of rill-like features of a minuter class, the smaller river-beds, which he finds have a tendency to occur in groups. Among these, he instances the curious clefts lying north of the Harbinger Mountains, one on the north-eastern quarter of the floor of Petavius (extending from near the central mountains to the wall), with a second, possibly of the same type, on the west of it, and others in Boscovich, west of Plato, Kästner, north of

Gassendi, and elsewhere. These objects, only a few miles in length, and a few hundred feet in breadth, are, unless of considerable depth, by no means easy to see.

Among the variable spots observed at Arequipa, were the black irregular marking on the floor of Hansteen, eight spots within Alphonsus, and two within Atlas, (*a*) the well-known dusky area near the southern end of the floor, and (*b*) another, less obvious, on the north-west of the central mountains, near the wall. Altogether in the space of three months a catalogue was formed of thirty-eight craters or regions, each of which contains one or more of these features.

The results as regards Alphonsus and other craters situated near the centre of the disc show that the spots become darkest immediately after full Moon. As there cannot possibly be any appreciable shadow at this time, Prof. Pickering remarks:—"It is evident that *there is a real change produced in the nature of the reflecting surface.* We do not know of any kind of stone which is gradually darkened by the action of sunlight, and which later, as the sunlight fades, grows lighter again. If called upon to offer an explanation of the phenomenon, we seem forced to call in the aid of water as an active agent." The difficulties surrounding this supposition and in imagining that the darkness may be due to frozen ground, partially thawed, are, however, increased by the observed fact that one of the spots of Alphonsus covers and darkens the slopes of a small hill near the rampart. "Vegetation would undoubtedly explain away all our difficulties; but before we resort to such an extremity it is evident that we need more facts upon which to base our theories. Vegetation can hardly exist without the presence of some moisture; but it is not necessary that it should appear in the form of ponds or rivers." Seven of the variable spots within Alphonsus have a central craterlet, while the largest includes two large craterlets and five small ones, none of which exceed 3000 feet in diameter. In the case of the smaller spots they are symmetrically arranged round the craterlets.

The spots, whether in Alphonsus or elsewhere, are clearly not dependent on the *phase* of the Moon. Prof. Pickering finds, for example, that those near the western limb attain their maximum of darkness just before full Moon, those near the centre after full Moon, and those near the eastern limb about the last quarter, thus showing that the duskiness has no relation to the position of the observer, but to that of the Sun with respect to the spot. These dark areas differ also in tone *inter se.* Some are light grey, some dark grey, and others black, when at their maximum; and there appears to be an evident connection between their tone and the times, both when they attain their maximum and when they fade away, the lighter spots reaching their full tint two or three days after they come into sunlight, and the black ones taking some three days longer. This phenomenon appears, however, to be modified by the latitude of the spots, for in low latitudes the dark spots appear earlier and disappear later. In almost every instance they are devoid of colour, though those in Endymion, Cleomedes, and Furnerius display a yellow hue, with perhaps, in the case of the first, a suspicion of green. One of the most interesting and elaborate of these dark spot investigations relates to that on the south side of the interior of the ring-plain Atlas, to the variations in the shape of which I drew attention in the 'Observatory' of December 1893. This object lies at the lowest level on the convex floor, occupying an area of 40 miles by 13, including 13 craterlets, varying from 6500 to 1600 feet in diameter, and intersected by a number of rills of surpassing delicacy. Prof. Pickering has reproduced nine drawings of this remarkable formation made during the months of February and March 1893, showing the suggestive changes in the extent and tone of the area which occurred at various times during this period. Unfortunately, it is hopeless in a less favoured part of the world to attempt to see a tithe of the detail revealed to him under the ideal conditions which prevail at Arequipa, but the variations in the depth of shade and in the visibility of this and many other dark spots he specifies might well form a subject of careful investigation.

It has been only possible to give a very brief and imperfect account of the lunar observations described in this volume, but enough has been said to indicate the extremely interesting character of its contents. From the portion devoted to lunar photography it may, however, be well to quote a paragraph which contains, among other things, an opinion, which, when stated by the present writer, was somewhat keenly criticized. "It is sometimes asked," remarks Prof. Pickering, "why it is that with the large telescopes and the sensitive plates now employed, better photographs of the Moon cannot be obtained. The best photograph of the Moon ever taken will not show what can be seen with a six-inch telescope, under favourable atmospheric conditions—perhaps one might say with a four-inch telescope. For general outlines, for completeness of the coarser detail, and for purposes of future testimony, the photograph evidently stands without a rival; but as regards that which is really most interesting upon the Moon—the finer detail, and more delicate features—the photograph does not even hint at their existence. The case is not all analogous to the photography of nebular detail, or of faint stars, as might at first be supposed. In these cases the eye owes its inferiority to the lack of light. But in the case of the Moon no such inherent difficulty arises; there is always plenty of light, no matter what the magnification employed, and the eye will probably always show its superior defining power over the photograph. Nevertheless, there is ample opportunity for improvement in the photographs of the present day, which are really but little better than those of thirty years ago."

Beaumont House, Shakespeare Road, T. GWYN ELGER.
Bedford, 1895, March 18.

# CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

## *The April Lyrids.*

GENTLEMEN,—

The ensuing return of these meteors occurs under favourable conditions as regards moonlight, for our satellite will be practically absent from the sky on the night of the 20th. The shower passed unobserved in 1894, the Moon being full on the morning of the 20th.

The April meteors rarely form a striking display; but from an astronomical point of view the stream is an important one, for it can boast a cometary parentage, and its radiant is probably the only one, besides that of the Perseids, which shows displacement on successive nights of observation. This feature requires further investigation; but it is a difficult one to attack, as the shower endures only a short period (April 16–23), is seldom a plentiful one, and the motion of its radiant from day to day is comparatively small and not easily separable from the errors in determining its position. To meet the case it is desirable to pursue observations during the entire night, so as to gather as many paths as possible, and these must be very correctly registered and undoubtedly derived from the Lyrid system by their directions of flight and traits of appearance.

On April 20 the radiant is about 1° N. of the star 104 Herculis (mag. 5), and is often very exactly defined. Not a year passes which fails to furnish some of its meteors, for, like the Perseids of August, it forms a display of annual recurrence, though it is rarely comparable with the August shower in point of richness.

Yours faithfully,

Bristol, 1895, Mar. 24. W. F. DENNING.

## *Eclipses and Chronology.*

GENTLEMEN,—

Since I wrote you in January in regard to the eclipses of the 'Rig Veda,' I have made some calculations in reference to the earliest recorded Chinese eclipse—namely, that of Ho and Hi. I find that that eclipse has been referred to no less than eight different dates by different investigators; but I also find that none of the eclipses occurring on those dates correspond to the tradition concerning it. The dates to which the eclipse has been referred are the following:—B.C. 2193, 2174, 2169, 2165, 2159, 2155, 2137, and 2128. None of the eclipses occurring on these dates were total in China, and only one of them was visible in that country. But I do not think the tradition requires a total eclipse. Any eclipse of sufficient magnitude to be readily noticed by the agricultural population of a vast empire would be all the tradition requires, aside from the season of the year at which it took place. I have endeavoured to find an eclipse which was visible in China, and which occurred on the day of the autumnal equinox; but the only eclipse in the above list which was visible in China was that of B.C. 2137, October 21, or eleven days after the autumnal equinox. That eclipse was central and annular from Cabul in Afghanistan to the island of Hainan, and was visible as a large eclipse at noon to the whole of China. The annulus, however, was very broad, so that the greatest magnitude of the eclipse along the central line amounted to only about 11·5 digits. I find, however, that the very next year, or twelve lunations after the above eclipse, another eclipse took place on the very day of the autumnal equinox, which was also visible about noon throughout the whole of China. Therefore I incline to the belief that the eclipse of the Sun which took place B.C. 2136, Oct. 10, was the one to which the tradition refers. At that date the Sun's longitude was 180° 15′; and the eclipse was visible as far south as the twenty-third degree of north latitude.

This eclipse fully satisfies the tradition; and I venture to believe the reason it was not predicted by the astronomers Ho and Hi was because they were thown off their guard by the eclipse of the preceding year, as it is a very unusual occurrence for the eclipses of the Sun in two consecutive years to be visible at the same place. The former eclipse occurred when the Moon was distant less than four degrees from her node, while in the latter case she was nearly eleven degrees from her node. The magnitude of the eclipse of B.C. 2136, Oct. 10, at Pekin was somewhat more than four digits, while in the more northern parts of the empire it amounted to more than six digits; and it was the only eclipse visible in China on the day of the autumnal equinox during a period of several hundred years.

While on the subject of eclipses I wish to add a word in regard to the eclipse mentioned by Julius Capitolinus. Mr. Lynn, in the February number of the 'Observatory,' seems inclined to believe that the eclipse of A.D. 240, August 5, was the one referred to; but that was even smaller than the one in A.D. 237 April 12; and according to Oppolzer's 'Canon' it must have been nearly over before sunrise at Rome. According to my own calculations it was greatest at Rome about $6^{h}\ 15^{m}$ in the morning, at which time ten digits were eclipsed. My reference to Struyck was second-hand, and taken from a memoir on the "Theory of the Moon's Motion," by G. Seyffarth, which was published in the 'Transactions of the Academy of Science of St. Louis,' vol. iii. no. 4, 1878. He refers to page 353 of Ruperte's Magazine; but I have been unable to verify his reference. In that work Seyffarth has given references to more than one hundred ancient eclipses; and while I regard his astronomical inferences as entirely worthless, his classical references seem to be generally trustworthy.

My attention has lately been called to a recent work on "Olympia," by Adolph Boetticher, which was published about a dozen years ago. On page 400 of that work, when speaking of the Olympic games, the writer says: "There is little or nothing preserved of the last two centuries. The latest inscription with list of victors dates from Olympiad 257 (252 A.D.): and the latest inscription of any kind, from Olympiad 261 (268 A.D.)." This historical statement, taken in connection with a recent dispatch from Athens concerning the revival of the Olympian games, and which states that the 669th Olympiad will be celebrated in the year 1896 A.D., is very gratifying, since it shows that the historical evidence agrees with the astronomical evidence which I have derived from the ancient eclipses, concerning the dates of their celebration. Very cordially yours,

Cleveland, Ohio, 1895, March 5. JOHN N. STOCKWELL.

## *The Comets discovered by De Vico.*

GENTLEMEN,—

The recent investigations of M. Schulhof and Mr. S. C. Chandler have fully confirmed the conjecture respecting the probable identity of De Vico's comet of 1844 and that discovered by Mr. E. Swift in 1894, which is also consistent with M. Tisserand's criterion. That comet was the first which was detected by De Vico, but as he was the first discoverer of five others afterwards, a few particulars respecting these may at this time be of interest.

In 1845, on February 28, he discovered a comet, which was independently detected by M. Faye at the Paris Observatory on March 6. It was always a faint object, but was observed until the 25th of April, four days after its perihelion passage. All the determinations of its orbit made this parabolic, except that the last of those of Jelinek and Hornstein (Astr. Nach., No. 546) showed deviation of an hyperbolic kind.

In 1846 De Vico discovered four comets. The first of these was found by him on January 24, shortly after it had passed its perihelion. (Mr. Chambers, in his widely read handbook, has, I know not why, attributed the discovery of this comet to Walker.) It was observed at Bonn until the 1st of May. The calculations of its orbit showed that it was probably moving in an elongated ellipse, with a period of nearly 3000 (Jelinek made it 2721) years.

The second comet discovered by De Vico in 1846 was first seen on February 20, and was independently detected by G. P. Bond on the 26th of the same month. It passed its perihelion on the 5th of March, and was followed at Washington until the 19th of May. The plane of its orbit is nearly perpendicular to that of the ecliptic, and the last determination of the values of the elements by Van Deinse give an ellipse with a period of about 73·25 years.

The third of these 1846 comets was discovered by De Vico on the 29th of July (nearly a month before its perihelion passage), and the same night, about two hours later, by Dr. Hind, then of Regent's Park. It was observed at Bonn until the 28th of August, but was throughout the time of being under observation small and faint.

The last of De Vico's cometary discoveries was made on the 23rd of September, 1846. The comet was observed at Hamburg until the 25th of October, and the perihelion passage took place about the end of that month. All the investigations of its orbit made it parabolic, except that Quirling's result was an ellipse with a period of about 1382 years.

With regard to the periodical comet of De Vico, M. Schulhof has shown that its comparative proximity to Jupiter in 1835 and 1886 caused an increase in its perihelion distance, which in 1894 was 1·514, though in 1844 it amounted to only 1·186. Le Verrier showed that it was probably identical with La Hire's comet of 1678, the perihelion distance of which was calculated (but the determination of the elements could not be very accurate) at 1·145. M. Schulhof thinks that the comet seen by Goldschmidt in 1855 may really have been De Vico's, which is evidently subject to fluctuations of brightness and was visible to the naked eye in 1844. He finds that it will make a close approach to Jupiter in 1897 (even nearer than in 1885), which will still further increase its perihelion distance, and probably render the comet very difficult of perception at the next return. Mr. S. C. Chandler thinks that this distance will afterwards considerably exceed that of Mars from the Sun, and that the comet will not come within reach of our telescopes for several returns, or until the attraction of Jupiter shall have in some measure reversed its former effect.

Yours faithfully,

Blackheath, 1895, March 13. W. T. LYNN.

## *The alleged Comet of* 1525.

GENTLEMEN,—

In your last number Mr. Lynn enquired if any of your readers could throw any light on the question whether a comet appeared in the year 1525. The earliest book on comets which I have been able to consult is that of Lavater ('Cometarum omnium fere Catalogus,' 1556), or rather the German translation of his book by J. J. Wagner, published at Zürich in 1681, as I do not possess the original. After mentioning the appearance of a comet in 1523, which was followed by rain and storms, he continues: "An. 1525 ist der Bauernkrieg entstanden, und König Franciscus wird von Carolo dem V. gefangen genommen." These events he evidently connects with the comet of 1523, but he does not know anything of a comet in the year 1525, nor of one in December 1524. The latter is mentioned by Lubienitzki, who quotes Luther (second hand, through Eckstorm's book on eclipses and comets, published in 1621) as the sole authority.

There seems therefore no evidence whatever of the appearance of a comet in 1525, and but a slender proof of one having been seen in 1524.

Yours truly,

Armagh Observatory, 1895. Mar. 19. J. L. E. DREYER.

GENTLEMEN,—

A brief notice of this comet is given in the 'Historia omnium Cometarum' of S. Lubieniezki, vol. ii. p. 326. "Anno Christi 1524. Apparuit Cometa hoc anno, nocte inter 9 et 10 dies Decembris .... Eckstormius ex Lutheri tom. iv. Jenensi. fol 27, b." The author begins the notice with the following remark:—

"Solus, quod sciam, Eckstormius hunc cometen annotat."

Yours faithfully,

C. LEESON PRINCE.

The Observatory, Crowborough, Sussex,
1895, March 18.

## *Variable Orange Stars.*

GENTLEMEN,—

May there not be another reason for Miss Brown's difficulty in identifying orange stars besides those she names—viz., that they may vary in colour? There are certainly many of those in Espin-Birmingham's Catalogue which have not at all a striking orange colour. The question is—Have the observers been mistaken in their observations, or have the stars changed in colour? I can't help thinking the latter is the most probable explanation, especially as many orange stars are known to vary at least slightly in colour. Probably the investigations of the Coloured-Star Section of the British Astronomical Association may throw some light on the question.

West Hendon House, Sunderland,
1895, Mar. 19.

T. W. BACKHOUSE.

## *The Total Lunar Eclipse of March* 10.

GENTLEMEN,—

Several of the occultations during Total Lunar Eclipse, mentioned on page 11 of the "Companion" to the 'Observatory,' were readily observed here with a power of 50 on 3¼ inches. 83 Leonis disappeared at $2^h\ 14^m\ 39^s$ A.M. Pi. xi. 71 at $2^h\ 15^m\ 22^s$ A.M. Unfortunately the bedewing of the object-glass at the time prevented the observation of emersion of these two. At $2^h\ 53^m\ 38^s$ τ Leonis disappeared sharply although at the reddened limb; B.W. xi. 349 disappeared 24 seconds afterwards.

τ Leonis emerged $3^h\ 44^m\ 40^s$; a faint star at $3^h\ 46^m\ 55^s$; W.B. xi. 349 $3^h\ 47^m\ 59^s$.

The times here given are "local mean," the clock correction being found by sextant observations.

The brightness of τ Leonis, a 5th magnitude star, hidden by the totally eclipsed Moon, brought before one's mind the first occultation ever recorded in England, when Jupiter was occulted during the total eclipse on the evening of November 23, A.D. 755. Modern calculations seem to indicate the time at from about half-past seven to half-past eight. (See Roger of Hoveden.)

The time when the umbra reached and covered the principal lunar formations was noted down, also their emergence from shade in an inverse order. To mention these would occupy space. The usual gradations of colour were gone through. At 3.30 the Moon was of a very dark red, with a patch of duskiness stretching across the central regions, probably owing to the very deep immersion in the Earth's shadow. As early as 1.35 A.M. the penumbra seemed just discernible to the naked eye. One minute before the actual contact with the real shadow it was well marked over a third of the Moon's surface on the eastern limb. From first to last there was not the intervention of a single cloud though with a low barometer, 29°·4.

Faithfully yours,
S. J. JOHNSON.

Melplash Vicarage, Bridport,
1895, March 11.

## PUBLICATIONS.

THE CAPE CATALOGUE OF STARS FOR 1885·0—Dr. Gill has recently published his first star catalogue. This consists of the places of 1713 stars deduced from the results of the meridian observations at the Cape from 1879 June to 1885 February, reduced, *without proper motion*, to the Equinox 1885·0. The italicized words indicate a departure from the general practice in forming modern catalogues. The corrections for Proper Motion to reduce the places to the adopted equinox are not included in the Catalogue places, but are added in separate columns. For the rest, the catalogue is of the usual form, Declination being printed instead of North Polar Distance, and the precession and secular variation given for each star. In addition to star names, there are printed, for reference, the corresponding rotation numbers of the catalogues of Bradley, Lacaille, Piazzi, and others, and of all previous southern catalogues.

But it is rather to the introduction to a catalogue that one turns for instruction and matters of interest; to learn in detai on what system the observations have been made and reduced and how the places have been formed. From this we note tha Dr. Gill has departed from the plan hitherto followed in previous Cape catalogues, where the places of the Greenwich clock-star lists have been used as the basis of the Right Ascension, and has used the clock stars of the 'Fundamental Catalog für die Zonen Beobachtungen am Nordlichen Himmel' to give his zero of Right Ascension. No reason is given for the adoption of this method but it may be connected with the fact that one purpose of the work at the Cape was to observe Fundamental Stars for the meridian observation of stars of Schönfeld's 'Durchmusterung.'

It is to be regretted that no investigation of the position of the ecliptic from solar observations is given to show the error, if any of the adopted equinox.

In observing transits a "reversing prism" eyepiece was used

In this apparatus a small reflecting prism is placed between the eye-lens and the observer's eye. The prism being in one position the star appears in the telescope to move from west to east; the transit over three wires having been observed, the prism is rotated through 90°, which is easily effected, which causes the star to appear to move in its normal direction, and the transit over the last three wires is observed. This practice, followed out in all observations since 1880, November, was induced by the fact that an examination of previous observations showed that each observer had a personal equation differing for stars culminating north from that for stars south of the zenith, in which cases it will be seen that stars move in opposite directions relative to the observer's right and left hand. The observations with the reversing prism show that the difference due to direction also exists in this case, is of the same sign, and for some observers of approximately the same magnitude as in the first case. Dr. Gill thinks that observation with the eyepiece, as described above, probably eliminates the error due to varying personal equation dependent on difference of zenith-distance of the star. No doubt Dr. Gill realizes that the use of the prism alters the apparent magnitude of the star, and hence probably the observer's personal equation, by quantities of the same order of magnitude as those of which he is treating.

Turning to the formation of the declinations of the catalogue, we are face to face with points of contention mentioned in our notice of the Radcliffe Catalogue in last month's number. In forming the places of the Cape Catalogue, a flexure correction of $-0''\cdot46 \sin$ z.d., derived from observations of the horizontal collimators, has been applied to the zenith-distances. The zenith-points used were those determined from nadir observations, and no correction has been applied for the discordance between observations made by reflexion and by direct observation; but these results have been reconciled by applying a correction deduced from the observations to the zenith-distances found by reflexion. The refractions used have been computed by the formulæ of Bessel's 'Tabulæ Regiomontanæ,' unaltered, and the adopted latitude, which results from the observations of circumpolar stars, is 33° 56′ 3″·35 S., sensibly agreeing with the latitude of Mr. Stone's Cape Catalogue 1880, in which the value was 33° 56′ 3″·41.

Several pages of the Introduction are spent in justification of these methods, especially of the non-adoption of the R—D correction, which Dr. Gill thinks is probably due to effects of abnormal refraction within the Observatory, and hence that the difference is wholly due to the reflection observation. As evidence in support of this view, comparison was made between zenith-distances found by the transit-circle with those found by the zenith-telescope, which instrument, however, is admitted to have been faulty. As further bearing on the question there is a lengthy discussion of the correction necessary to the constant of refraction from comparison of observations at Greenwich and at the Cape, the latter being taken in two ways—first as given in the Catalogue, without the R—D correction, and secondly with the R—D correction. On the second hypothesis the result arrived at is that at Greenwich the refractions should be diminished by a $\frac{1}{1000}$th part, at the Cape by $\frac{1}{200}$th part, while on the first hypothesis these fractions are respectively $\frac{1}{2000}$ and $\frac{1}{600}$, a difference which Dr. Gill thinks to be evidence in favour of his view. It is curious to note that the observed differences between the Cape Direct and Reflexion observations, treated by the usual method, show a variable term of the form $+0''\cdot47$ sin z.d., which is almost identically the same, but with reversed sign, as the flexure correction applied—that is, if the flexure had not been applied, the R and D observations would practically have been in agreement.

But while Dr. Gill thinks that at the Cape the observed R—D difference is a refraction effect, he seems to imply that the same present difference at Greenwich is a flexure, because it agrees with flexure determinations made in the years 1850–1864.

As a check on the determination of latitude, Dr. Gill sought the co-operation of Dr. O. Struve at Pulkowa, who furnished observations of 22 stars for a determination of the latitude of the Cape by Talcott's method. The latitude thus determined agrees very satisfactorily with the determination by comparison of Cape and Greenwich meridian observations, as pointed out by Dr. Gill (Mon. Not. vol. lv. p. 35).

Summing up his discussions, Dr. Gill expresses a want of confidence in transit-instruments which are not reversible, and states his belief that many observed discordances may be explained by refraction due to non-equality of the temperature within and without the Observatory, to obviate which he describes elaborately a plan for an ideal Transit-Circle room, which we should like to see realized. While not following Dr. Gill altogether in all his conclusions, we heartily congratulate him on the accomplishment of this Catalogue, and on giving with such freedom his views on some vexed questions to the astronomical world.

---

ANNALS OF THE ASTRONOMICAL OBSERVATORY OF HARVARD COLLEGE: Vol. XXXII. part I. INVESTIGATIONS IN ASTRONOMICAL PHOTOGRAPHY.—The investigations were carried out by Prof. W. H. Pickering in the years 1887–1891. The Annals are divided into three chapters:—

I. Fundamental Principles: dealing with the telescope, production of negative, enlargement, actinic absorption, size of star-images, stellar magnitudes, &c.

II. The Great Nebula in Orion.

III. Visual and Photographic Observations of the Lunar Surface.

In Chapter I. Prof. Pickering enters fully into the kind of instrument to be employed for the several branches of astronomical photography, and he sums up his experiences thus:—"Where the best definition is required, as for purposes of measurement, a refractor should be used. In order to photograph the faintest stars possible, use a reflector of the largest practicable diameter, and of such focus as will make the star-images of the smallest possible size. To photograph the faintest nebulæ, either a reflector or a doublet may be employed; but for ordinary nebulæ the reflector has the advantage." Considerable care has been given to the determination of photographic stellar magnitudes, and Prof. Pickering says, "the principles underlying the photographic photometry adopted at Harvard differ in two important respects from those in general use elsewhere. We measure magnitudes by comparison with a photographic scale, instead of measuring the size of the images themselves, and we adopt the visual magnitudes of average first type stars as standards, making the photographic magnitudes conform to them, instead of taking a certain star as a standard and assuming that a star whose image is equally distinct with two and a half times the exposure is one magnitude fainter. This ratio of $2\frac{1}{2}$ times the exposure, which has been adopted by the Paris Conference, is, to say the least of it, of doubtful accuracy, that is, if we wish it to correspond to a difference of $2\frac{1}{2}$ times the light. We have found in our work that the ratio three gives results that accord very well with those obtained by visual observation, but it probably varies somewhat with the exposure and the brightness of the star, and certainly with the kind of plate employed."

With regard to these remarks on photographic stellar magnitudes we would point out that a good deal has been done in this direction since Prof. W. H. Pickering made his researches, and it would seem from a paper in the Monthly Notices of the R.A.S., 1892, January, by the Astronomer Royal, that the scale adopted by the Paris Conference is on the whole borne out by subsequent experience.

The chapter on the Orion Nebula contains descriptions of photographs given in the several plates, the magnitudes of the stars near the trapezium, structure and spectrum of nebula, proper motions of stars in vicinity of nebula, size and distance of nebula; a fine photograph of the nebula is given as a frontispiece.

---

ANNALES DE L'OBSERVATOIRE DE PARIS.—The two bulky annual volumes for 1886 and 1887 have just come to hand. These two, published under the direction of M. F. Tisserand, contain the usual meridian observations and annual catalogues, equatoreal observations of comets, small planets, &c., the whole showing a great mass of work done. From time to time the Paris Observatory publications contain theoretical and practical essays, which have been duly appreciated from their completeness, on the various branches of astronomical work. The volume for 1887 contains one of these essays, or rather, in this instance, treatise, which is v worthy the Observatory traditions. Its title is "Instructi théoretiques et pratiques pour le service méridien de l'Observat de Paris, par M. Périgaud," and we cannot recall a more compl exposition of meridian work. When we say that it monopoli 250 pages of the large volume, and that it is *illustrated by figures*, we may be excused going further, as it is difficult to se passages for illustration from so much good reading. A m glance at the list of the subjects treated serves to remind us the infinity of detail which is not generally noticed in every-work.

---

## NOTES.

Comet Notes.—In the 'Astronomical Journal,' No. 338, th is an article by Dr. Chandler on the identity of E. Swift's Co with that of De Vico, which he considers practically establisl He has computed approximately the perturbations at the tim the close approach to Jupiter in 1885, and gives the follow three sets of elements, all for the equinox of 1890·0. The set is deduced from Brunnow's orbit of De Vico's Comet with perturbations, the second set from the present apparition with application of the above perturbations, while the third set is same as that published last month.

| $T=$ | 1882 Dec. 7·7 | 1883 Feb. 5·5 | 1894 Oct. 12· |
|---|---|---|---|
| $\omega$ ...... | 278° 49′ | 283° 7′ | 296° 34′ |
| ☊...... | 64 20 | 60 24 | 48 41 |
| $i$ ...... | 2 55 | 2 53 | 2 58 |
| $\log q$.... | 0·07423 | 0·09858 | 0·14364 |
| $e$ ...... | 0·61765 | 0·60282 | 0·57190 |
| $\log a$.... | 0·49177 | 0·49959 | 0·51210 |
| $\mu$ ...... | 649″·15 | 631″·86 | 605″·15 |
| Period .. | 5$^{y}$·466 | 5$^{y}$·615 | 5$^{y}$·863 |

He accounts for the fact that the first two sets are not in ex accord by the neglect of the perturbations in 1873, and of higher terms of those in 1885. The discrepancies are all in right direction. The perturbations in 1897 will be greater tl in 1885, and will probably throw the perihelion outside the o of Mars, so that Dr. Chandler considers it doubtful if the co will ever be seen again.

Ast. Nach. 3276 contains a computation of the definit elements of Comet 1842 II. (Laugier) by Karl Schwarzsch The comet was visible from Oct. 28 to Nov. 27, and 88 obser tions are available. The places of the comparison stars have b revised, and proper motions deduced and applied where practica The final orbit is as follows:—

T = 1842 Dec. 15·99401 Berlin M.T.

| | | |
|---|---|---|
| ω ...... | 240° 32′ 19″ | 1842·0. |
| ☊ ...... | 207 48 45 | |
| $i$ ...... | 106 25 57 | |
| log $q$.... | 9·702767 | |

In the same number there is an article by Dr. Schulhof on the connection of Comet 1894 I. (Denning) with Brorsen's Comet. He thinks it likely that the comets had originally a common origin, but that the separation must have taken place long before 1881, and that perturbations by Mars as well as by Jupiter are required to account for the modification of the orbits. Both he and Dr. Lamp have published improved elements of Denning's Comet, as follows:—

| | Schulhof's Elements. | | Lamp's Elements. | |
|---|---|---|---|---|
| Epoch | 1894 Mar. 28·0 Paris M.T. | | 1894 Mar. 28·0 Paris M.T. | |
| M .... | 6° 11′ 0″ | | 6° 7′ 28″ | |
| ω ...... | 130 37 45 | 1890·0. | 130 39 59 | 1894·0. |
| ☊ ...... | 84 21 51 | | 84 15 51 | |
| $i$ ...... | 5 31 48 | | 5 32 9 | |
| φ ...... | 44 17 40 | | 44 25 15 | |
| $\mu$ ...... | 478″·363 | | 474″·267 | |
| log $a$.... | 0·580166 | | | |

Dr. Schulhof thinks that his value of $\mu$ is certainly not more than 8″ in error, which implies an error not exceeding 30 days in the deduced period.

Dr. Lamp has examined the subject very exhaustively (Ast. Nach. 3278), and his conclusions are not quite the same as those of Dr. Schulhof. He carefully brought up the place of Brorsen's Comet to 1881 Feb. 12, applying perturbations by Jupiter and Saturn, and then worked back the place of Denning's Comet on the same day with approximate perturbations by Jupiter, but found an interval of several months between the passage by the two bodies through their common line of nodes. He then deduced the improved elements of Denning's Comet given above, and computed accurately the perturbations by Jupiter back to 1881. He found that the least distance between the orbits was 198·82 radii of the Earth, and the two comets passed through the corresponding points of their orbits on 1881 Jan. 17·56 and Jan. 23·93 respectively. The diameter of the coma of Brorsen's Comet is given as 37·7 radii of the Earth, so that there is no doubt that the two bodies made a very close approach at the beginning of 1881, and the elements of Denning's Comet may admit of sufficient alteration to reduce the distance still further. It returns to perihelion about 1901 Aug. 2, and the question whether it is a fragment of Brorsen's Comet should then be set at rest. Dr. Lamp notes that his statement in Ast. Nach. 3271, that the value of $\mu$ in Schulhof's first elements would have to be altered by 28″ on the hypothesis of identity, was erroneous; a much slighter alteration is necessary.

The following search ephemeris of Comet 1884 II. (Barnard) is by Dr. Berberich (Ast. Nach. 3260); it is for Berlin midnight:—

|  | R.A. |  |  | S. Decl. |  |  | R.A. |  |  | Decl. |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | h | m | s | ° | ′ |  | h | m | s | ° | ′ |
| Apr. 24.... | 21 | 35 | 9 | 20 | 53 | June 3 .. | 23 | 57 | 26 | 6 | 27 S. |
| May 2.... | 22 | 5 | 36 | 18 | 24 | 11 .. | 0 | 22 | 7 | 3 | 22 |
| 10.... |  | 35 | 16 | 15 | 38 | 19 .. | 0 | 45 | 20 | 0 | 24 S. |
| 18.... | 23 | 3 | 54 | 12 | 40 | 27 .. | 1 | 6 | 59 | 2 | 25 N. |
| 26.... |  | 31 | 20 | 9 | 35 | July 5 .. | 1 | 27 | 2 | 5 | 2 |

There is a probable error of 20 min. in R.A., 3° in Decl.

A. C. D. C.

MINOR PLANET NOTES.—The two planets BR, BS, whose discovery was announced last month, prove not to be new, but identical with (379) and (333) Badenia respectively. Two more planets—BT, BV—were discovered by Wolf on March 16 and 15 respectively, and two others BU, BW by Charlois on March 15 and 21.

A. C. D. C.

THE TOTAL LUNAR ECLIPSE OF MARCH 10.—It has been so much the case at Greenwich, of latter years, for clouds to prevail on the occasion of special phenomena, that the splendid sky during the recent Eclipse of the Moon is worth mentioning. The advantage of a lunar eclipse, from the astronomer's point of view, is considered nowadays to lie in the fact that observations can be made during or near totality of occultations of faint stars which would be impossible under normal circumstances. This class of observation was initiated in 1884 by Prof. Döllen, who has circulated for use in co-operating observatories lists of stars to be occulted during the eclipses of the four last total lunar eclipses. Dr. H. Struve's discussion of the observations made during the eclipses of 1884 and 1888, to find a value of the lunar diameter, will be within the memory of our readers. There were comparatively few stars to be occulted during this year's eclipse, the list given in the 'Companion' contained almost all of them, but some were fairly bright and well placed for observation. For such events as these at Greenwich all available instruments are brought into use; on this particular occasion the battery numbered 11 telescopes, including the photographic telescope of the astrographic equatorial, which was used by putting a plain glass plate in the camera frame, against which the observer held an eyepiece. Twenty-one phenomena were observed in all, each by several observers, giving an aggregate total of 135 observations. We believe we are right in saying that the accordance of the observations is as good as could be wished.

The comparatively bright colour of the totally-eclipsed Moon was remarked by everyone. The mean of the opinions of the Greenwich observers seems to be that the colour could be described as dark orange or light copper, with blue markings around the limbs (one observer says these markings were occasional). A writer in a contemporary compares the colours of the Moon in recent total eclipses thus:—In 1884 it looked like a penny ten years old, in 1888 like a brand-new penny, and in this year's eclipse like the same coin after a few months' circulation.

It is perhaps worth recording that an observer saw τ Leonis, one of the occulted stars, with the naked eye, about 2½ minutes after reappearance, and also before disappearance, at about the same distance from the limb.

---

THE PARTIAL SOLAR ECLIPSE OF MARCH 26.—The sky at Greenwich on the morning of last Tuesday was completely overcast, wholly preventing any observation of the solar eclipse, although arrangements had been made to take some photographs of the very partially obscured Sun, and to make observations of time of contact. We give the following communication from Mr. Prince of Crowborough, the only account of observations of the phenomenon yet to hand:—

"The weather this morning was stormy and the sky densely overcast, so that little hope could be entertained of seeing anything of the partial eclipse; nevertheless, I adjusted my equatorial upon the Sun's place, and waited for any chance which might occur of seeing the Sun's limb.

"At $10^{m}$ $9^{s}$ L.M.T. I first noticed a break in the clouds, but it was not in the neighbourhood of the Sun's place. At $10^{m}$ $13^{s}$ the clouds cleared away sufficiently to enable me to see a very slight indentation in the Sun's limb. At $10^{m}$ $15^{s}$ the sky became comparatively clear, and, considering that the air was very moist, definition was good. I could now see a very small portion of the Moon's limb upon the Sun, but it was sufficient to clearly show two lunar elevations very sharply defined, the following one being the larger. From this time, with the exception of a little scud passing at intervals, the Sun's disc continued free from cloud until the time of last contact, which occurred very approximately at $10^{h}$ $19^{m}$ $5^{s}$, and was exactly at the point of the following elevation. As I apprehend that nothing was seen of this eclipse in many parts of the kingdom, I thought these few notes might be of interest."

---

ZONE TIME IN AUSTRALIA.—In the time system adopted in Australia since February 1 last, which we announced last month, we find that the zones are bounded by the meridians which define territories rather than by meridians selected uniformly. In West Australia the time used is that of the meridian 120° East of Greenwich. As this territory is bounded on the East by the meridian about 129° East, the zone extends only approximately 7½° on either side of the standard meridian. South Australia, with the country north of this, and the western part of Victoria keep the time of the meridian 135° East. This zone in its southern part therefore extends almost exactly 6 degrees on either side of its standard meridian.

The remainder of the Continent, Queensland, New South Wales, and almost all Victoria have the time of the meridian 150° East of Greenwich as standard. The time at Sydney is now, therefore, 4 min. 51 sec. slow on its actual local time.

FROM a cutting in the 'Cape Times' of March 4, we learn that there is a proposal under consideration to make the time of the meridian two hours East of Greenwich the Standard Time for the whole of South Africa. At present it seems that the standard time is exactly 1½ hours fast on Greenwich, in accordance with a resolution passed at the Bloemfontein Railway Conference in 1892, after somewhat hasty consideration.

ASTRONOMY IN NEW SOUTH WALES.—We are pleased to hear of the formation of a branch of the British Astronomical Association in New South Wales, which the President of the branch, Mr. John Tebbutt, in his opening address spoke of as preliminary to the establishment of an astronomical society in the colony. Other officers of the branch are Mr. Walter Gale, an enthusiatic amateur, renowned for his discovery of a comet in 1894, who is secretary, and Mr. R. T. A. Innes, a vice-president, who devotes himself more to the mathematical side of the science: Mr. H. C. Russell, director of the Sydney Observatory, is a member.

ON the night of March 13, between the hours of 6 P.M. and midnight, active magnetic movements (but to moderate extent) were recorded. The Aurora Borealis of the arched form was observed at many places in the North of England between the hours of 8 and 10 P.M., when characteristic changes were being shown in the magnetic curves. No conspicuous sun-spots were visible on or about this date.

WE hear with regret of the death of Mr. Richard Dunkin, a member of a family connected for two generations with official astronomy. Mr. Dunkin's father was on the staff of the 'Nautical Almanac' in its early days, and his elder brother, now enjoying honourable retirement, was for many years a well-known member of the Greenwich staff. The deceased gentleman worked at Greenwich from 1838 to 1847, when he joined the staff of the 'Nautical Almanac,' from which office he retired in 1883. Mr. Dunkin died on February 19, after a short illness, aged 71.

THE vacant post of Junior Assistant at the Royal Observatory, Cape of Good Hope, has been filled by the appointment of Mr. John Power, formerly of the Greenwich staff.

MR. A. R. HINKS, of Trinity College, has been appointed Second Assistant at the Cambridge University Observatory.

The portrait of the late Professor CAYLEY which appears as a frontispiece to this number was drawn by the Cambridge Engraving Company from a photograph taken by Mr. A. G. Dew-Smith about two years before Professor Cayley's death.

---

## FROM AN OXFORD NOTE-BOOK.

Of the reports of observatories given in the recent Annual Report of the Royal Astronomical Society, none are more noteworthy than those from our Australian friends, who are working hard under the discouraging circumstances of financial depression. "Additional workers," says Mr. Russell, "are urgently needed, but in the present depressed times there is no hope of increasing the staff." The amount achieved, however, must give the Director of the Sydney Observatory every cause for satisfaction. Notwithstanding the numerous calls made by the public upon his time and attention, and that of his two assistants, he has managed to take nearly the whole of the Catalogue plates for the Astrographic Chart. In illustration of the magnitude of these interruptions he remarks that "217 persons have called to see me upon scientific matters, 830 persons have called to see the observatory, and 97 have applied by letter for information which has involved 28 days' work to supply." The trouble which Mr. Russell will take to help others is indeed known far and wide. I have been told by the engineer charged with some cable-laying operations in which a knowledge of the coming weather was of the first importance, that the information supplied constantly and assiduously by Mr. Russell rendered work comparatively secure and certain which would have been otherwise dangerous and problematical; from which we may gather two things: firstly that forecasting is more of a scientific possibility in Australia than in the British Islands; and, secondly, that Mr. Russell rightly recognizes that if he can secure results of this importance to the public (which there is no one else to attempt), he would be doing Astronomy but a sorry turn to neglect them in order to push forward astronomical observation a little faster.

---

THE Director of a Government observatory is in fact not solely an astronomer—we might perhaps say not an astronomer in the first instance. He is the scientific adviser of the Government on innumerable points; directly responsible for public works, such as the time-system and the management of chronometers; and, generally speaking, the head of an office where an immense amount of business is done. He must personally supervise the work much more closely than in most offices where the work can be organized into routine. Such organization is doubtless useful in an observatory; but there is also no greater danger than that of drifting into routine in the case of an advancing science, a hence those in charge are continually re-examining machin which appears to be working perfectly. When all this is membered (and the importance of remembering it cannot be strongly insisted on), the reports from Melbourne and Syd will be read with unmixed admiration. Sir Charles Todd has s us no report this year; he is even more occupied with depa mental matters, being Postmaster-General and Superintendent Telegraphs, and it is almost impossible for us in England realize how three such important persons can be rolled into o We may certainly hope that when financially brighter times arr men who have shown themselves capable of so much will be a to secure a great advance in the organization of astronomy in southern hemisphere.

A CORRESPONDENT writes, with regard to the want of uniform in size of astronomical publications referred to two months a "If astronomers find publications of different sizes a nuisa (and it is so), think of the meteorologist, who gets still m exaggerated types, as though arranged for the purpose of giv trouble." It is, alas! only too easy to point out such needs reform, and far too difficult to suggest a remedy. We are fami with the disadvantages attending the "solution by conferen especially when the conference is large. There is a saying of late Prof. Froude, that "In a Committee you get the united f and not the united wisdom of the whole"; and though we n not give an unqualified assent to this caustic remark, we have had occasion to compare the actions of an individual and o committee to the disadvantage of the latter. Probably we sho all agree that the strength of a conference or committee lay in discussions, and its weakness in its decisions and resolutio There is nothing but gain in the free discussion of a subject, without comparison of different views progress would indeed slow; but progress may possibly be retarded by resoluti not absolutely unanimous, which irritate a minority into o opposition. This was strikingly illustrated in the case of Washington Prime Meridian Conference, where the all-but-una mous resolutions failed to act because of the irritation minorities. It is conceivable that a Conference where no re lutions, professing to be binding, were passed might have bet prepared the way for settlement of the questions between tw three responsible persons. On the other hand, the results ai at seem happily to be coming about by slow degrees instead of *saltum*, so that the resolutions have done no permanent harm; cept this only, that by missing fire they cause a future mistrust such Conferences. It has been already twice mentioned in th columns that the Council of the Royal Astronomical Society h carefully considered Dr. Gill's proposals for an Astronomical C ference in 1900, and that the Council did not feel able to proceed in the matter was chiefly due to this mistrust of the definite Resolutions which might be arrived at—a mistrust not merely on their part, but expressed by distinguished foreign astronomers as well. If this feeling continues it would appear that in cases where it is desirable to attain uniformity (whether in sizes of publications, or system of reckoning time or coinage) we should look to Conferences rather as a means of more rapidly comparing views than of arriving then and there at decisions. The advantages of an assemblage of persons for discussion, over discussion through the press, are undoubted; and it is probable that if attendance of such an assemblage did not involve adherence to resolutions, the meetings would be freer, pleasanter, and more successful in every way.

"I BELIEVE," said Professor Barnard in his lecture last evening in Y.M.C.A. Hall, "that people who ordinarily are supposed to only appreciate such reading-matter in the daily papers as pertains to prize-fights and horse-races will be found to be deeply interested in astronomical subjects, if the same are only placed before them in an easily intelligible form. . . The papers, good as they are, and perfectly wonderful as they are, in getting news that interest the public, do not fully realize yet the interest taken by the masses in astronomical discoveries" (San Franscisco Examiner, 1895, Feb. 10). This paragraph occurs in a very well reported account of the lecture and of an interview with Prof. Barnard; an account with illustrations, head-lines, and all the other devices for securing the attention of those who read, not exactly as they run, but as they travel by express train. This particular paper, in fact, seems to have taken the hint, and realized for once how attractive a three-column article could be made out of the occasion. But is not Prof. Barnard encouraging rather false hopes? Part of the attraction in the case of horse-racing is certainly the continuity of the news; those who appreciate such reading-matter are rewarded by finding, for a large part of the year, something of fresh interest every day: they open their daily paper with that expectation. Now Astronomy has nothing to lose by the dissemination of results when these are obtained; but to encourage the daily papers to look with any regularity for astronomical news of a popular character would seem rather dangerous to its best interests. News of this kind is scarce. The occasions of an eclipse or other unusual events are, of course, to be excepted, for here the weather supplies the "sporting" interest, and everyone is keenly interested in weather. But ordinarily the tendency is, perhaps, already to publish results too soon instead of working them out thoroughly, and any encouragement of news-gathering would probably increase this tendency, and is therefore to be deprecated.

Of the occultations noted and other observations during the recent total eclipse of the Moon adequate accounts will be given elsewhere. I may perhaps be permitted here to reproduce a paragraph from 'The Sketch' dealing with the occurrence from another point of view, and an uncommon one. So far from blaming the eclipse (as might have been done by them of old time) for the epidemic, the writer blesses the epidemic for giving him a view of the eclipse. Can he really have had this depressing malady?

"One is not inclined to be grateful to the influenza for anything; but let us give the devil his due when possible, and I must confess that, thanks to this abominable complaint, which seems, among other evil attributes, to rob its victims of their proper share of sleep, I enjoyed a most excellent view of the eclipse of the Moon the other Sunday night, or rather, Monday morning. The sky was most admirably arranged for the show, being perfectly cloudless when the eclipse was first turned on, about 1.30 A.M., and the whole business was most enjoyable, even without a telescope, which is not, unfortunately, one of the necessities of a sick-room. It was really a perfect night, and, when the Queen of the Heavens was thoroughly eclipsed, the stars shone with wonderful brilliance. My view was shared by a constable in the street below (the only other star-gazer I saw), and he seemed remarkably interested, and made notes in his pocket-book. Whether he was a member of the Royal Astronomical Society, or whether he thought the affair mysterious, and one to be reported to his Superintendent, I have not yet been able to discover."

---

An amusing printer's error was caught in a "revise" the other day. In the MS. occurred a sentence beginning "Thanks to the skill which made the giant mirror." In the proof the word giant was altered to the more specific "20-inch"; but the quality of the hand-writing caused the printer to interpret the correction a little differently, and in the revise the phrase stood "Thanks to the skill which made the 20-mile mirror." This reminds us of a verse which occurred in an astronomical lampoon circulated some little time ago. A reference to lunar craters is introduced, and the verse proceeds:—

"A company's been formed to cut away the Central Cone;
  Our Treasurer's the Managing Director,
And he'll polish up the bottom by a process of his own
  As a hundred-thousand foot reflector."

Though even this is scarcely 20 miles.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

No. 227. MAY. 1895.

## MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Wednesday, April 10, 1895.

Dr. A. A. Common, F.R.S., *President*, in the Chair.

*Secretaries*: Prof. H. H. Turner, M.A., B.Sc., and E. W. Maunder.

The Minutes of the previous Meeting were read and confirmed.

*Mr. Maunder.* 71 presents have been received since the date of the last Meeting. Among those calling for special notice may be mentioned an astronomical scrap-album, presented by the executors of the late Mrs. Jackson-Gwilt; three pastel drawings of the Moon by Mr. John Russell, R.A., presented by Mr. McClean; and a number of enlargements of negatives taken by MM. Loewy and Puiseux, showing portions of the Moon's surface, presented by Dr. L. Weinek. The scale of these pictures corresponds to a lunar diameter of 4 metres.

*The President.* In asking you to return your thanks to the donors of these presents, I would like to add a few remarks about the three presents specially mentioned by Mr. Maunder. The album bequeathed by Mrs. Jackson-Gwilt is well worth looking through by anyone who takes an interest in personal astronomical matters. There are photographs taken in early days of some persons well known to us; there are some photographs of the late Mr. Proctor, and of other persons not quite so well known. It includes also several other interesting things which I am sure are well worth perusal. The early specimens of lunar cartography made by a Royal Academician, who devoted his attention to this particular branch (presented by Mr. McClean), look rather rough at a first glance, but I am given to understand by those who have examined them that there is more truth in them than appears from the crude manner in which they are made. The enlargements of the Paris photographs made by Dr. Weinek appear to me to be the most wonderful things which have been done in lunar pho graphy up to the present time. They surpass everything yet do The reason of my opinion will be apparent when it is remembe that we have here photographs in which the Moon's diame would be represented by 13 feet, and that there are little crat ¼ inch in diameter which are quite discernible. The accuracy the representation of the shadows of the mountains struck me being most remarkable.

A vote of thanks was accorded to the donors of the presents.

*Prof. Turner.* Several papers call for particular mention t evening. Mr. Innes sends a paper on the Occultation of Ant on 1894 Oct. 11. He calls attention to the curious observa of the companion of Antares at reappearance after occultati Mr. Innes says: "I observed this occultation with Mr. Ga 6¼-in. refractor, with a power of 190. The reappearance happe after the Sun had set, but still in strong twilight. I notic faint bluish light, which seemed to stretch towards the Mo limb, and then Antares flashed out. I then saw that the faint bl light I observed was Antares' companion. Until Antares emer Antares seemed to be connected with it by the Moon's limb o an electric arc." Mr. Innes recounts this occultation, beca he noticed that a communication from Mr. Tebbutt, a very observer, did not mention the reappearance of the companion- fact, he said it not appear. It is an interesting occultation, the account comes at an appropriate time, as we have sev papers on occultations observed during the recent lunar eclips

*Mr. Newbegin* read a paper on the "Total Eclipse of the M 1895 March 10," and exhibited six photographs which were ta with his 9-inch equatorial, the plates being placed in the fc The first was taken six minutes after first contact of the M with the Earth's shadow, and others at intervals up to the mi of the eclipse and one just as the Moon reappeared.

In showing a photograph of the very partially eclipsed Sun 1895 March 25, he said:—So many clouds were passing from north-west that the first observation of the eclipse was at 22 Greenwich Mean Time, when the eclipse had already begun. $22^h$ $13^m$ the photograph was taken, and it was estimated that eclipse was then at its maximum. At $22^h$ $24^m$ the Sun was a visible, and it appeared that the eclipse was then over. photograph showed three distinct mountains projected beyond Moon's limb.

*Mr. Stone.* The terminator or line defining the shadow on Moon, as I observed it, had nothing like the sharpness show the photographs of the lunar eclipse just exhibited, for the ecli Moon was not entirely lost sight of to the naked eye; and limb did not terminate abruptly with the fully illuminated po of the limb, but could be seen much like the young Moon is sl by the earth-shine.

*Capt. W. Noble.* I should like to ask Mr. Newbegin what wa colour of the Moon visible to the naked eye at total phase. As I saw it when totally eclipsed it was of a brilliant copper colour, almost inclined to scarlet, but across the middle of the disc there was a kind of grey blot which obscured everything; it looked as if there were a gigantic fire on the Moon, and that the smoke had gathered towards the middle. My opinion is that these different shades of colour are due to the Earth's atmosphere.

*Mr. Newbegin.* So far as I can judge, but my eyesight is very imperfect, I should say that the Moon was fairly luminous. I do not know whether it was so in the eclipse of 1892; I think I got better photographs then than I did on this occasion.

*The President.* With reference to what Capt. Noble said about the appearance of the totally eclipsed Moon, although it is well known that the Moon is seen of different colours and brightnesses in different eclipses, I do not think this variation has been properly accounted for. I have a complete series of photographs taken during the lunar eclipse of 1875, and in these the encroachment of the shadow is shown in the most vague manner. There is nothing at all resembling a sharp defining line as is shown in these photographs of Mr. Newbegin's. During the eclipse of 1875 I never lost sight of the Moon all through the eclipse. There are other papers which treat of this recent lunar eclipse from another point of view. On such occasions it is possible to make observations of occultations which are impossible at other times, and I will invite remarks on this subject.

*Dr. Spitta.* I was going to ask Mr. Newbegin a question. He called attention to the fact that he gave a long exposure to try to obtain an image of the Moon when it was of a copper colour, and, as we see, got no image. Is not this due to the fact that the ordinary plate is not sensitive to the red rays? He might have got a picture with an isochromatic plate.

*Mr. Newbegin.* I think Dr. Spitta is quite right. An astronomical friend, who used isochromatic plates, got a picture during total immersion I believe.

*Mr. Waters.* Is it possible that any portion of the luminosity on the Moon may be due to the low temperature of our satellite and that the effect is similar to that which has recently been produced by Prof. Dewar on bodies of very low temperature? In an eclipse we have the circumstance of a body at a low temperature which has been exposed to the light of the Sun; and if there is anything which phosphoresces, the phosphorescence might be seen on the Earth.

*The President.* There is one point which has not been satisfactorily explained. The exposure that Mr. Newbegin gave during the total phase was quite sufficient to have enabled stars to impress themselves on the plate. I would ask Mr. Newbegin if he has made any search on the plate to see if any stars are shown. Stars of the sixth magnitude ought to be visible on the photograph.

*Mr. Newbegin.* I have looked very carefully, and I thought I did see the trace of a star; but I am not sure of this.

*Mr. Crommelin.* There is a circumstance which seems to indicate that the Moon during totality is shining by reflected light; and that is, that the outlines of the seas and other markings retain their configuration and relative luminosity unchanged. Were the Moon visible by inherent light there is clearly no reason why this should be the case.

*Mr. Bryant.* Is it not possible that the different appearances of the Moon in different eclipses may be due to different states of the Earth's atmosphere in the regions 90° away from the place at which the Moon is in the zenith?

*Prof. Turner.* The papers on the occultation of stars seem to be of some interest. I do not know whether the Astronomer Royal will tell us anything about the observations at Greenwich, where eleven observers seem to have been employed. Looking at the paper one point presents itself to me, and that is that there seems to be some evidence of personality in the observations. Some observers seem to note the phenomena always later than others. I think on previous occasions of this kind—in the eclipses of 1884 and 1888—it was noticed that in the cases of faint stars different observers did show a personality. Dr. L. Struve, in determining the lunar diameter from these observations, I think came to the conclusion that this method did not give such an accurate result as he had hoped. There seemed to be a systematic error of a more serious kind than is usual in occultations of brighter stars.

*Mr. Stone.* Does this personality exist in the case of reappearances as well as of disappearances?

*Capt. Noble.* In that case the matter is a differential one, ar the two observers, even if one were later than the other in bo cases, would get the same value of the Moon's diameter.

*The Astronomer Royal.* I should like to say, with regard these Greenwich observations, that, as many observers were av able, several of them had to use small portable instruments a chronometers, and were therefore working under somewhat favourable conditions. Looking at these observations as a wh I was much impressed with the very small range in most cas and bearing in mind that a second of time represents, at most, only about a second of arc in the lunar diameter, an some cases very much less, it seems to me that these occultat are accurate enough to give a very good value of the Mo diameter, as good as can be expected in such a case in vie the irregularities in the limb. It is an unfortunate circumsta in this particular eclipse, that the Moon's centre passed to south of all the stars, so that the determination from Green observations alone will not be so good as it might have been u other conditions. It is to be hoped that these observation be supplemented by those at other observatories, so that a good result for the Moon's diameter may be obtained.

*Mr. Newall.* In the observations made at Cambridge there is a curious discrepancy. On comparing the observations made by two quite independent observers, the observed times of disappearances in most cases show a very good agreement, the differences being about one third of a second of time. But the only marked difference is in the case of the brightest star—a fifth magnitude star—and is as large as 1½ seconds. There seems no reason to assign an error to one observation rather than the other.

*Mr. Crommelin.* I think the considerable personality which Prof. Turner has mentioned as detected by Dr. Struve was with regard to very small stars. In the case of nearly all the observations at Greenwich the stars were staringly visible up to the limb. Our working list consisted only of stars contained in the Bonn 'Durchmusterung.' The personality was not in the losing of the star, but in estimating the time of the chronometer beat.

*Mr. Dyson.* There is one point to be remembered, and that is that, as the observatory now extends over such a large area, in comparing observations by different observers small corrections should be applied depending on the place of observation.

*Prof. Turner* read a paper by *Mr. W. R. Brooks* on a modified form of Cassegrain telescope, which was on a plan similar to that proposed recently by Dr. Common. Mr. Brooks stated that the method was thoroughly worked out by him in 1884, and he was glad to corroborate the results obtained by Dr. Common, and he believed that Dr. Common's results would be crowned with perfect success.

*Prof. Turner* then read a paper by *Dr. Common* on the brachy telescope of Messrs. Fritsch and Forster, of Vienna.

*The President.* It is a very interesting point I make in this note on the reflecting telescope of Messrs. Fritsch and Forster. There is no doubt that Dr. Schroeder had in his mind these gentlemen when he told me that these telescopes had been made in Germany. It is rather remarkable that, consequent upon Mr. Brooks' letter in the 'English Mechanic,' some other person should point out that this plan had been made by someone in England before 1825.

*Prof. Turner.* I propose that the thanks of the Meeting be given to Dr. Common for his paper. Capt. Hills and I can testify to the interest we felt in visiting Ealing the day before yesterday. The 5-foot is undergoing alterations. The big stage on which our President used to mount to the eye-end is no longer necessary and has been taken down; a second tube is being attached to the existing tube of the 5-foot, and everything is being arranged so that the instrument shall be made in this new form, with which observation will be practicable from a low stage at the end of the telescope familiar to the observer with a refractor. We must acknowledge that our President has the courage of his convictions when he is demolishing to that extent the 5-foot as he originally planned it. We shall hope for good results from the new telescope.

In introducing a paper on observation of the collimators through the cube of the Greenwich Transit-circle, the *Astronomer Royal* said:—

This is a short note on observations made at Greenwich some years ago, in 1884–5, to test a point to which Dr. Gill, following up a remark of Prof. Newcomb, has recently called attention. The point is raised in connection with the determination of flexure of the Greenwich transit-circle, and the question amounts to this: Was the change in flexure observed in the year 1867 a real change, or was it only an error in the determination due to setting the collimator wires in coincidence through the cube instead of with the instrument raised clear out of the way? It is known that there is a difference in the two methods in the case of the vertical wires which are used daily for determination of collimation, and these observations now presented were made with the view of determining whether a similar difference existed in the case of the horizontal wires. They were made on seven occasions when flexure was determined in the years 1884 and 1885; but, unfortunately, when the flexure results were printed, these details were omitted, as it is not usual to give them, but I have now thought it well to publish these observations. It will be seen that the differences of the readings for coincidence of the wires of the North and South collimators in the two positions of the instrument are very small, the mean of the seven determinations being represented by about 0″·09: and as the effect on the determination of the flexure would be only half this, viz. 0″·045, I cannot place any confidence in the idea that the observed change in the flexure was due to a change in the method of observation.

*Mr. Stone.* I am glad the Astronomer Royal has brought forward this matter, because some years ago a statement was made that there was no proof whatever of flexure in the Greenwich transit-circle caused by the piercing of the cube. I had a strong feeling myself about the matter at the time, and made some observations relating to the subject. The point brought forward now is of considerable importance with regard to this question, and it is very desirable that these observations should be repeated from time to time. I have a distinct recollection that similar observations were made at the time that the cube was pierced.

*Mr. Thackeray* then read a paper on the value of the nutation constant found from meridian observations of Polaris made at Greenwich from 1836–1892. Some years ago, after the Greenwich transit-circle had been in use some twenty years, Mr. Stone discussed the Greenwich Observations (Mem. R. A. S. v. p. 35), and found that the resulting value of the nutation constant was somewhat smaller than that found by Peters. More recently Prof. Newcomb has discussed the observations from 1851–1889, and got a somewhat similar result. The results of the whole period now treated of give a value of this constant which is persistently smaller than that of Peters and practically the same, whether deduced from the observations of Right Ascension or Declination. The results of each year's observations have been reduced to 1890 by Chauvenet's formula, and the values of the proper motion (adopted from the observations) of $+0^{s}\cdot1200$ and $+0''\cdot005$ for the epoch 1890·0. A graphical representation of these results showed discordances in Right Ascension, which suggested personality as a probable cause; and the observations have therefore been discussed for this purpose on the same lines as was done in the case of the Sun. Mr. Criswick was taken as standard observer, and on the assumption that his personality remains constant for the period covered by his observations (of which there is no proof to the contrary), corrections have been deduced and applied to the observations, the range of which was in general some $2^{s}$, the result being that the discordances were not removed, the value of the nutation constant already derived was not materially altered, but that the resulting value of the proper motion was considerably changed, viz. to $+0^{s}\cdot1550$, and the discordances assumed an appearance of a periodic character, which would be fairly satisfied by a 40 years' curve with an amplitude of $1^{s}$.

*Mr. Stone.* This paper is very interesting to me, because it is a continuation of work I did some years ago. Mr. Thackeray has, however, in working up his results tried to reduce them down to the habit of Mr. Criswick as the standard observer. But there is no proof that Mr. Criswick's habit has remained the same over 35 years. Whilst the number of observers employed at Greenwich has sometimes led to apparent roughness in the observations, yet it is, after all, one of the strong points of the Greenwich system when we come to the discussion of systematic errors extending over long periods of time; because I think the mean habit of a large number of observers is less likely to change than the habit of a single observer over a long interval.

*Prof. Turner.* This paper seems to me to be an extremely valuable one, dealing as it does with the results of nearly half a century's observations at Greenwich. I hope it is but one of a series of papers analyzing the results which have been accumulating for so long. The personality question is an important one; and although Mr. Thackeray has arrived at a negative result, showing that the personality is not very large, it is a valuable one, because it is a positive result also. It shows one can trust the mean of a large number of observers better than a single one.

*Mr. W. W. Bryant* then gave the substance of a paper on Pallas and Vesta, which consisted of a list of stars with their places near which these planets would pass during the ensuing summer.

This, he said, was for the benefit of observers who proposed making micrometer or photometric observations.

*Prof. Turner* read a paper by *Mr. Dennis Taylor* on "A Negative Optical Proof of the Absence of Seas in Mars." Mr. Taylor suggested that if there were water on Mars, and it was in an undisturbed state, we ought to see a minute image of the Sun formed in the surface of the water, and that this would show as a 1st or 2nd magnitude star, and he regarded the absence of any such appearance as a negative optical proof of the absence of seas. Since the paper had been first written it had been modified, because it appeared that Schiaparelli had dealt with the question before, and Prof. Phillips had also raised the question. Mr. Taylor had made some experiments with a thermometer-bulb illuminated by a candle, and placed at such a distance as to more or less represent Mars to scale. The general argument was distinctly in favour of the conclusion that if there was any water on Mars, even of the width of a canal which could not be less than a few miles—Mr. Taylor took an area of six or seven miles in diameter as sufficient to give an appreciable bright image such as a 2nd magnitude star—if there was water on that area he thinks we ought to get the appearance of such a star. He deals cursorily with the roughness of the sea, his argument being that there must have been moments when it was calm. Of course, if the seas were always rough, the reflection would be diffused; but Mr. Taylor has concluded from his experiments that even then if there were any water on Mars we should see a bright patch.

*Capt. Noble.* Some few years ago, another Fellow of the Society brought an instance of what he called specular reflection before us; I think at that time it was in the case of Venus; but instead of there being a point of light on Venus, it was suggested that the appearance was of the shape of a sausage.

*The Astronomer Royal.* I should like to ask whether Mr. Taylor has taken any account of the diffusion of the atmosphere of Mars, because in considering the reflection from Venus that was an important modifying circumstance, and the question is how far this will modify the shape of the point of light and spread it out to such an extent that it would hardly be appreciable to our eyes.

*The President.* There is one point that is very interesting, and that is the connection between the light from a star and the light from the Sun. What proportion does a 1st magnitude star bear to the light of the Sun? It is given by different authorities from 40,000 millionths to something more and something less. Now by the specular reflection from Mars, supposing it have a perfectly reflecting power, we have a means of estimating what magnitude star would be seen under those conditions. If we take it that the Sun would be fully reflected from a convex mirror of the same curvature as Mars, which would give an image of 7 miles in diameter, we can easily conceive that the whole surface of the visible hemisphere might be covered with such specula. Now in the hemisphere when Mars is near opposition we find that about 135 million million such specula could be placed; that is to say, we can get reflected light from that number, but the light is not fully reflected. If we have $\frac{1}{50}$th of the light which falls perpendicularly upon the surface of water reflected, a rough calculation shows that we might get a 12th or 13th magnitude star reflected from the convex surface of the water on Mars.

The following papers were announced and partly read:—

*John Tebbutt.* "Equatorial Comparisons of Jupiter and λ Geminorum."

*W. R. Brooks.* "On a Modified Form of Cassegrain Telescope."

*H. F. Newall.* "Note on the Total Eclipse of the Moon, 1895 March 10."

*T. Lewis.* "Note on η Cassiopeiæ."

*R. T. A. Innes.* "Occultation of Antares, 1894 October 31."

*A. W. Roberts.* "Parallax of α Centauri and β Centauri, from Meridian Measures made at the Royal Observatory, Cape of Good Hope, 1879-81."

*Dr. A. A. Common.* "The Brachy Telescope of Messrs. Fritsch and Forster, of Vienna."

*Radcliffe Observatory, Oxford.* "Observations of Occultations of Stars during the Lunar Eclipse of 1895 March 10."

*G. J. Newbegin.* "The Total Eclipse of the Moon, 1895 March 10, and the Solar Eclipse of 1895 March 25."

*W. W. Bryant.* "Pallas and Vesta in 1895."

*Royal Observatory, Greenwich.* "Observations of Occultations of Stars during the Total Eclipse of the Moon, 1895, March 10."

*Royal Observatory, Greenwich.* "Note on the Observations for Coincidence of the Collimators made through the Cube of the Greenwich Transit-Circle."

*J. L. E. Dreyer.* "Observations of the Partial Eclipse of 1895 March 25."

The following Candidates were proposed for election as Fellows of the Society:—

*John A. Ferguson*, Newlands, Oak Hill, Surbiton, S.W. (proposed by H. B. Chamberlin).

*George Andrews Hill*, Assistant Astronomer, United States Naval Observatory, Washington (proposed by James E. Keeler).

*Ernest William Hobson*, Fellow of Christ's College, Cambridge (proposed by J. W. L. Glaisher).

*Rev. J. Dunne-Parker*, LL.D., Bennington House, Stevenage, Herts (proposed by Robert Wigglesworth).

## BRITISH ASTRONOMICAL ASSOCIATION.

The fifth ordinary meeting of the present session was held on March 27th at University College, Gower Street, Mr. E. Walter Maunder in the chair.

*Mr. B. E. Cammell* read the report of the Mars Section.

*The President* congratulated Mr. Cammell on the success of his Section during the past opposition, and on the promptness with which he had presented his report. The number of drawings sent in was just double that which had been received in 1892, indicating an increasing interest in this department of work.

*Miss Everett* gave abstracts of a number of reports of the total eclipse of the Moon of March 10, sent in by Mr. Gwyn Elger (Director of the Lunar Section).

*Mr. Henry Ellis* described his unsuccessful attempt to photograph the eclipsed Moon with his 12-in. reflector.

*Mr. G. J. Newbegin* stated that he had been equally unsuccessful in a similar attempt.

*Miss Everett* thought it might interest members to know what was done at the Royal Observatory at Greenwich on the occasion of the recent eclipse. The weather conditions were almost perfect. 137 observations of disappearance or reappearance of 14 stars were recorded by the 11 observers engaged.

*The President*, in thanking Mr. Elger and the members of the Section who had co-operated with him in the observation of this eclipse, remarked that it was seldom that they had so good a chance of observing these rarer phenomena at Greenwich, as they had on this particular occasion, for they were noted for their ill-luck in the matter of weather. One of the great puzzles about lunar eclipses was the great difference from one eclipse to the other in the brightness of the Moon, and he did not think that any completely satisfactory explanation had yet been given. He thought that the failures to photograph the eclipsed Moon were to be accounted for by the extreme faintness of the light. Prof. Pickering had estimated that the eclipsed Moon was as much fainter than the Moon as the full Moon was fainter than the Sun.

*Mr. Hardy* suggested that there might be a condition of latent light. He thought that the terms "dark coppery tint" and "red tint" were too vague. He was inclined to describe the tint as roseate.

*The President* reported that Mr. F. W. Levander had been appointed Hon. Librarian, and that Members would be able, by appointment with Mr. Levander, to change their books on other than meeting days.

*Mr. Petrie* read papers on the "Zodiacal Light," by *Mr. Henry Corder* and *Mr. S. M. B. Gemmill*, and a note on the same subject by *Miss Brown*.

*Mr. Joseph Lunt, B.Sc.*, read a paper on "Stellar Photography without a Driving-Clock." Mr. Lunt pointed out that the users of the splendid telescopes of the International Survey of the Heavens had many difficulties to contend with which were not felt by the users of small photographic telescopes and cameras, and that while the larger instruments must be driven by elaborate machinery, the smaller instruments such as he had used could be driven without clockwork at all, the stars being followed without even a slow-motion rod, a gentle hand-pressure being all that was required. His guiding telescope was a 2¼-in. by Cooke fitted with cross-wires, and by placing the star-image considerably out of focus, he had no difficulty in bisecting the disc by both cross-wires, so that any inequality in the four quadrants could easily be detected. He used Edwards's instantaneous isochromatic plates, and the stars showed on the negatives as beautifully circular sharp impressions. With half-an-hour's hand-driving, stars down to the 10th magnitude were secured, whilst an exposure of an hour on the Pleiades gave stars of the 11th magnitude.

Mr. Lunt's paper was illustrated by a number of lantern-slide reproductions of his photographs.

*Mr. Newbegin* thought Mr. Lunt was to be congratulated on the beauty of the work which he had done.

*The President* said it was certainly no small achievement to have obtained such beautiful photographs without the assistance of a driving-clock. It opened a very considerable field to many who hitherto must have felt that the field of astronomical photography was closed to them.

*Mr. A. J. S. Adams* read a note on "Apparent Umbral Protrusion, and its Effect upon Foreshortening in Solar Groups;" and *Mr. Petrie* read a paper by the *Rev. T. M. Foulkes, M.A.*, on observations of the Planet Jupiter on March 4, 1895.

---

## ROYAL METEOROLOGICAL SOCIETY.

At the Meeting of this Society on Wednesday evening April 17th, which was held at the Surveyors' Institution, Westminster, Messrs. F. C. Bayard and W. Marriott communicated a paper on "The Frost of January and February 1895 over the British Isles." The cold period, which commenced on December 30th and terminated on March 5th, was broken by a week's mild weather from January 14th to 21st, otherwise there would have been continuous frost for 66 days. Temperatures below 10° Fahrenheit, and in some cases below zero, were recorded in parts of England and Scotland between January 8th and 13th; while from the 26th to the 31st, and from February 5th to 20th, temperatures below 10° occurred on every day in some part of the British Isles. The coldest days were February 8th to the 10th. The lowest temperatures recorded were $-17°$ at Braemar, and $-11°$ at Buxton and Drumlanrig. The mean temperature of the British Isles for January was about

7°, and for February from 11° to 14° below the average, while the mean temperature for the period from January 26th to February 19th was from 14° to 20° below the average. The distribution of atmospheric pressure was almost entirely the reverse of the normal, the barometer being highest in the north and lowest in the south, the result being a continuance of strong northerly and easterly winds.

The ill-effect of the cold on the public health was very severe, young children and old people especially suffering. The number of deaths in London due to diseases of the respiratory organs rapidly increased from February 2nd to March 2nd, when the weekly number was 1448, or 945 above the average. Rivers and lakes were frozen, the ice in some places being more than 10 inches thick.

The frost will long be remembered for its effect on the water-pipes all over the country, in many cases householders being without water for more than 9 weeks. As the result of enquiries the authors find that mains have frozen which have been laid as low as 3 ft. 6 in. from the surface of the ground to the top of the pipe. It appears, however, that the nature of the soil had far more to do with the depth to which the frost penetrated than the intensity of the frost itself.

From a comparison of previous records the authors are of opinion that the recent frost was more severe than any since 1814.

Mr. Birt Acres also read a paper on "Some Hints on Photographing Clouds."

---

## *The Solar Eclipse of* 1896 *August* 8.

As it appears from some earlier notes in the 'Observatory' that preparations will be made in England for observing or seeing the total eclipse of the Sun next year in Norway, perhaps the following remarks may be of interest to some readers as supplementing the information given by other correspondents.

Last summer I had occasion to spend most of the month of August in the neighbourhood of Vadsö in making astronomical observations. I had to determine the latitude, the difference of longitude from Christiania, and an azimuth at the eastern end of a base line measured there some years ago for the Geographical Survey.

The weather was more variable than is usual in lower latitudes. On one of the early days (July 30) when the installation was going on, and the portable observing-hut had not yet been erected, I had to observe in a gale of north wind with a temperature of 4° C. This is hard work, but everyone who has had experience of field observations in Norway will be prepared for it. As long as the temperature was low, about 10° C., the observations were often interrupted by clouds or fog. This was not a sea-fog; it often came drifting from the inland, as is very common on the "Fjeld" in Norway, but in lower latitudes only in greater heights above the sea-level. In the middle of August a remarkable change took place. For some days the temperature of the air went up to 25° C. in the daytime, mostly with a clear sky. In favourable weather my working day began about noon and lasted to 4 or 5 in the morning. Some of the nights of this period were extremely fine, with Mars, Jupiter, and Venus (the two latter circumpolar) sparkling in the clear summer sky about midnight. Later on the weather was spoilt by thunder coming up from the south and a falling temperature.

I think the chances for observation of the eclipse will be about the same as in the temperate zones with a low Sun.

The character of the country in the eastern part of Finmarken is quite a contrast to that of Nordland. While the latter has high and steep mountains with alpine forms, the land on the north side of the Varangerfjord (Nord-Varanger) is gently undulated and comparatively low. Already some few hundred metres behind the town of Vadsö the character of the "Fjeld" is marked by the creeping dwarf birch (*Betula nana*) and a little farther from the coast by numerous moors and lakes, reindeer-moss, etc. The above-named astronomical station was only 2 kilometres north of Vadsö and 126 metres above the sea; but nevertheless I had an almost perfectly free horizon, with a view of the whole Varangerfjord and a great part of the country, the Russian coast in the far east. Though not a single tree was visible (forests are only found in the inner parts of Syd-Varanger, on the other side of the Fjord) there would sometimes be a splendid view, especially with a low night Sun reddening the mountains of Syd-Varanger, which are in some parts a little higher, 400–500 metres.

Some of the several thousands of (so-called) tame reindeer which stray about quite by themselves in Nord-Varanger in this part of the year will occasionally come down to the coast. During my stay it happened two or three times that some hundreds of them came peacefully trotting past my tents.

The mapping of this part of the country is not far advanced; of the maps of the Geographical Survey in the scale 1 : 100,000 only four sheets have appeared, one of which represents a part of the coast of Syd-Varanger; but I am informed that some more sheets of Syd-Varanger and one of Nord-Varanger, containing the land about Vadsö, will be published in the course of this year.

As to the coast of Nordland, which will probably be visited not so much for observing as for looking at the eclipse, there are several islands and some accessible points on the coast with a sufficiently free horizon.

Lastly, I subjoin the following results of a calculation of the two inner contacts, made from the elements given in the 'Connaissance des Temps' (mean semidiameter of the Sun $15' \, 59''\cdot63$, of the Moon 15′ 32″·83, and Newcomb's corrections to Hans Tables) and expressed in *Mid-European Time*, which was introdu in Norway at the beginning of this year. P is the positi angle of the point of contact relative to the Sun's centre.

| | Lat. | Long. E. Gr. | 1st inner C. | P. | 2nd inner C. |
|---|---|---|---|---|---|
| | ° ′ | ° ′ | h m s | ° | h m s |
| Trænen ......... | 66 30 | 12 6 | 16 53 21 | 111 | 16 54 53 |
| Bodö ............ | 67 17 | 14 23 | 54 0 | 94 | 55 32 |
| Kautokeino ... | 68 58 | 23 3 | 55 24 | 105 | 57 5 |
| Karasjok ...... | 69 15 | 25 34 | 55 44 | 117 | 57 27 |
| Vadsö ......... | 70 5 | 29 46 | 56 59 | 103 | 58 44 |
| Ekkerö ......... | 70 4 | 30 8 | 56 57 | 109 | 58 44 |
| Vardö............ | 70 23 | 31 6 | 57 28 | 95 | 59 12 |

The point here called Vadsö is the above-named astronom station. The fact that Ekkerö, though 14 kilometres east Vadsö and farther on in the track of the shadow, has the 1 contact 2ˢ earlier and the last contact almost at the same mom as Vadsö (the moment of greatest phase is 1ˢ·1 earlier) is an effec the angle of 14° between the long axis of the very elonga shadow (Sun's altitude 14°) and the direction of the central li the azimuth of the first-named is about 83° and of the latter from north towards east. Though both Vadsö and Ekkerö ar little to the north of the central line, the last contact will for b stations take place in the south-west quadrant of the ne elliptic shadow.

With regard to the position-angles of the points of contac may be remarked that Bessel's original treatise on eclipses give formula for the *outer* contacts, which is also to be found elsewh sometimes (as in Brünnow's 'Astronomy' and the 'Connaissa des Temps') followed by an incorrect remark about the ann eclipse, but nothing about the total. I shall therefore, with brevity, develop the formula here used.

If A is a point on the Earth's surface, C the point of intersect between the axis of the shadow-cone and the plane through perpendicular to the axis, then, using Bessel's notation, M is position-angle of C relative to A. If A is situated on the surf of a shadow-cone, a plane through the line AC and the Su centre will cut the Sun's limb in two points, one of which is point of contact for which the angle P is sought. Now if A is the outline of the penumbra (outer contacts) or of the prolon shadow (annular eclipse), the line from A to the point of cont will cut the axis of the shadow-cone on the way to the Sun, consequently the position of the contact-point relative to the centre of the Sun will be the inverse of the position of A relative to C, and therefore the same as the position of C relative to A, *i. e.* P=M. But if A is on the outline of the real shadow (total eclipse) no intersection with the shadow axis takes place between A and the Sun, and the same reasoning gives P=M+180°.

If M is calculated for the right time, this will suffice. When P is to be expressed by the angles called by Bessel N and $\psi$, it can be made by putting $m$=L (partial and total) or $m$= −L (annular) in the two equations,

$$m \sin(\mathrm{M}-\mathrm{N})=\mathrm{L}\sin\psi \quad \text{and} \quad m\cos(\mathrm{M}-\mathrm{N})=\mp\mathrm{L}\cos\psi,$$

where the upper sign is adapted to the first of the two contacts considered if L is positive, to the last if L is negative, and *vice versa* for the lower sign; $\cos\psi$ being always positive.

This gives for $m$=L:

$$\text{Beg.}\left\{\begin{array}{l}\sin(\mathrm{M}-\mathrm{N})=\sin\psi\\ \cos(\mathrm{M}-\mathrm{N})=-\cos\psi\end{array}\right\}\text{that is, }\mathrm{M}-\mathrm{N}=180^\circ-\psi;$$

$$\text{End}\left\{\begin{array}{l}\sin(\mathrm{M}-\mathrm{N})=\sin\psi\\ \cos(\mathrm{M}-\mathrm{N})=\cos\psi\end{array}\right\}\quad ,,\quad \mathrm{M}-\mathrm{N}=\qquad\psi;$$

and for $m$= −L the same values with contrary sign for $\psi$.

These results, combined with the relations between P and M, give the following values of P for the three sorts of eclipses:

| | Beginning. | End. |
|---|---|---|
| Partial ...... | $\mathrm{N}-\psi+180^\circ$ | $\mathrm{N}+\psi$ |
| Total ........ | $\mathrm{N}-\psi$ | $\mathrm{N}+\psi+180^\circ$ |
| Annular...... | $\mathrm{N}+\psi+180^\circ$ | $\mathrm{N}-\psi$. |

University Observatory, Christiania,
1895, April 5.

H. GEELMUYDEN.

P.S.—Since the above was written and sent I have received the 'Nautical Almanac' for 1897 and 1898, where the Besselian elements for calculating eclipses are introduced. The notation used above is mainly the same as in the 'Connaissance des Temps,' but with the interchange for the total and annular eclipse of the sign of the quantity L. In this case the angle $\psi$ enters in the two last sets of formulæ above with contrary sign, so that the formulæ for the annular eclipse agree with those for the partial, and for the total the same expressions hold good when beginning and end are interchanged. H. G.

---

## *Some anomalous Sidereal Spectra.*

THE first proceeding of science is to lay down rules; the next, to note exceptions to them. Orderly arrangement is a *sine qua non* to progress; but no sooner is it fairly well established, than "residual phenomena" (to use Sir John Herschel's phrase) assert their importance. That stage has certainly been reached in researches regarding the spectra of stars and nebulæ. Not that their classification is entirely satisfactory. It is, however, comprehensive, and in its main lines so clearly marked out by nature that unconformable objects at once arrest attention and challenge careful scrutiny. Let us take a few examples.

Two of the great nebulæ offer peculiarities in the quality of their light which have as yet received little attention. The Trifid in Sagittarius evidently belongs to the gaseous class. Its greenish colour, irregular form, and situation in the thick of the Milky Way, plainly indicate its fundamental nature; and the Harvard observers in 1869–73 derived from it a spectrum consisting of one bright line, roughly measured as of wave-length 499, but identified unhesitatingly as the usual "air-line." Father Secchi perceived, besides the chief line, a trace of F. Nevertheless, only a short continuous spectrum, apparently limited to the green and blue, with a central brightening, the position of which could not be determined with a small spectroscope, was visible to Professor Keeler in 1890. It need hardly be said that the observations of his predecessors cannot in any way be compared with his. Further detailed inquiries, especially by photographic means, are, however, most desirable.

The spectrum of the multiple star planted at the inner extremity of one of the three lobes constituting this nebula makes another point of discrepancy. At Harvard College it was recorded as continuous up to wave-length 428, with many bright lines and some bands (presumably of absorption). At Lick no break in the prismatic light could be detected. Here, again, a spectrogram taken with a sufficiently powerful instrument would be of great interest, and might prove decisive as to the real connection of the star-group with the nebula in which it appears to be immersed.

The "looped nebula" surrounding the star 30 Doradûs is in appearance very unlike the Trifid. It seems as if made up of delicate luminous fibres woven into a large openwork pattern: and its situation as one of the multifarious inmates of the Greater Magellanic Cloud lends it peculiar interest. Its spectrum was first observed by Mr. C. E. Burton in 1874. With the inadequate means at his command he found it to be strongly continuous, but crossed by the distinctive green ray of that class of object. We are nevertheless curtly told in the forty-seventh Annual Report of the Harvard College Observatory (for 1892), that the spectrum in question is "unlike that of other gaseous nebulæ." In what respects unlike we are left to conjecture. The remark, however, opens up a train of reflections. Does singularity of spectrum, we ask ourselves, depend upon singularity of position? Can there be a chemical diversity between the nubeculæ and other sidereal aggregations? Or may not rather the course of development prescribed by the unique conditions prevailing in them differ from at pursued elsewhere? To these queries no answer can even hinted except through the intervention of the spectroscope. erhaps Dr. Gill may see his way to carrying out the necessary vestigations with the M$^{c}$Clean spectro-photographic apparatus to erected at the Cape, it is hoped. in 1896. It may be added at the determination of this nebula's line-of-sight motion would of extreme interest. If, however, its spectrum is to be made ailable for this purpose, it must include some known lines—me members of the hydrogen series, for instance, should the ief nebular ray be really missing from it. The movement when scertained, may, it is true, if conducted in a retreating direction, nd with moderate velocity, be considered as proper to the Sun ather than as proper to the nebula; but any that may remain ver and above will disclose one of two things—either a translation f the Magellanic Cloud as a whole, or an interstitial movement of he various masses jointly composing it. Having regard to the piral form of their arrangement, as photographed by Mr. Russell, irculation round a common centre is not indeed to be looked for; but the slightest indication as to their dynamical relations would be all the more welcome. It might afford the first clue to what now appears an inextricable labyrinth.

Stars of the fourth type are commonly distinguished by their deep red hue; a corresponding deficiency in their more refrangible rays accentuating and, after a manner, explaining the peculiarity. Yet it is not an essential feature of the type. Two stars unmistakably belonging to it were found nevertheless at Harvard College, in 1891, to be visually devoid of colour, and to show spectra well extended in the blue. They are both included in Schönfeld's 'Durchmusterung,' as −10°·513 and −10°·5057, and figure as Nos. 115 and 848 in the useful Catalogue of stars with banded spectra given in Frost's translation of Scheiner's 'Spectrum Analysis.' The former is of the eighth magnitude, and lies about three degrees north of ε Ceti; the latter, which is one magnitude brighter, is situated in the constellation Aquila. The slightness of continuous absorption in their spectra differentiates them remarkably from the curious objects they otherwise resemble, and brings them, provided that their rays be strongly concentrated, well within the range of the camera. The details of their spectra ought to prove highly instructive as to the nature and genealogical connexions of the type to which they in the main conform.

The variable R Geminorum may, perhaps, be ranked among its aberrant members. For, according to Vogel's observations in 1874, it exhibits at maximum *bright* carbon-bands instead of the dark ones characteristic of Secchi's fourth stellar class. Thus, the spectrum of R Geminorum is fundamentally—so far as we yet know—that of a comet. But it has not been observed for one-and-twenty years, so that its unique character needs confirmation.

Another neglected spectrum is that of the irregularly variable R Coronæ. Mr. Espin announced, in 1890, fluctuations in its racter which were the more surprising that during their tinuance the star varied little from the sixth magnitude— maximum brightness. At times its dispersed light appeared nost continuous; then dark bands would emerge, broad and rply terminated towards the red, like those of the fourth ctral type; bright lines of unknown origin being added. Here evidently much room for careful and exact enquiry. Many er tracks might be pointed out, the diligent pursuit of which ld hardly fail to lead to valuable results, if not to important coveries; but for the present these specimens may suffice.

A. M. Clerke.

---

## *Selenographical Notes.*

Godin and the Neighbourhood.—The region in which this ect and its larger and more northerly companion, Agrippa, is nated is remarkable for the complexity and interesting character the details it includes, which is hardly surpassed by any area of ial extent on the visible surface. Godin itself is a ring-plain abnormal shape, deviating notably from circularity, and is surnded by a rampart of considerable height, except on the south, h a crest exhibiting many breaches of continuity. These breaks especially noteworthy at sunrise, when the most conspicuous of m appears to be prolonged towards the south-west in the shape a trumpet-shaped valley extending for a considerable distance this direction, and bounded on either side by lofty ridges. der a later phase of sunrise, the terraces on the inner slope of eastern wall are seen to great advantage; they are more promit and definite than is usually the case in formations of such derate dimensions. Most observers who have examined the ghbourhood of Godin must have remarked a large pentagonal losure immediately on the south of it, and situated a little th of the lunar equator. It is about 45 miles in diameter, and ounded by linear ridges, those on the northern half of it being y bright and conspicuous under a rising Sun, while the remainder evidently lower, and consist of dusky mounds and rows of ocks. On the east side of this curious formation, abutting on wall, is the large deep depression (marked M in Neison's Map .), which, according to Schmidt, is associated with two small ters on the north and south of it respectively, and also abutting the border of the enclosure. The rim of this great cavity ears to be of very slight height and not at all conspicuous; so t when the Sun has attained a moderate altitude it is scarcely ceable. Between the bright crater on the south of Godin, rked *b* by Schmidt and Neison, and the pentagonal enclosure, a very remarkable circular plateau, nearly as large as Godin, out any apparent rim. That it is of some altitude is shown by fact that it stands out as a dusky circular area surrounded by black shadow beyond the terminator at sunrise, and when sunrise has sufficiently advanced it is bordered by a narrow but very definite band of shade. I cannot find any indication of the existence of this object, as I see it, on the maps, though I have frequently observed and drawn it.* Between $6^h$ $45^m$ and $7^h$ $15^m$ on March 3, this year, it was a decidedly prominent feature, the morning terminator passing a little east of Triesnecker. Its surface appears to be perfectly smooth and structureless, not a ridge or mound varying the monotony of its superficies. If it had a rim, it would recall the well-known formation of about the same size south of Herschel (Herschel *a*), for, like this, it is a flat plateau partly surrounded by concentric ridges, but, under no conditions of illumination, is there a trace of such an appendage. Beyond a comparatively small central mountain, the interior of Godin appears to be devoid of detail, though in a special map of the formation by Neison, under meridional illumination, he shows a number of light markings concentric with the border which would indicate the presence of many low ridges on the floor. He also appears to have seen the trumpet-shaped valley and its rocky boundaries very distinctly under these conditions. In another special map, drawn at sunrise, he records a crater on the inner slope of the east wall, and two others beyond the outer foot of the rampart on the south-west which are not shown elsewhere. The first appears to stand near a gap in the wall which is very evident under a very low Sun. Some little distance west of Godin is a remarkable semicircular formation some ten or twelve miles in diameter, bordered on the south by a bright massive border with spurs and buttresses extending towards the south-west, but open on the north. It is only doubtfully indicated by Schmidt, but more clearly by Neison, who also shows a smaller low ring on the rugged surface north-west of it.

Beaumont House, Shakespeare Road, T. GWYN ELGER.
Bedford, 1895, April 19.

---

## CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

### *Eclipses and Chronology.*

GENTLEMEN,—

I must crave space for a few (very few) more lines on this subject. It will be noticed that though Prof. Stockwell does not accept my view that the solar eclipse mentioned by Julius Capitolinus as having occurred early (the historian does not say in the first year) in the reign of the emperor Gordian III. was that of August 5, A.D. 240, his own calculations are quite consistent with that view, as he finds that the greatest phase (about 10 digits) of that eclipse took place about an hour after sunrise at Rome.

I have consulted Prof. Seyffarth's paper, to which he refers, on the "Theory of the Moon's Motion," in the 'Transactions of the Academy of Science, at St. Louis, Missouri.' The quotation from Ruperti's Magazine is as follows:—"Struyk maintains that two years later [than 237, which he also takes as the date of the eclipse mentioned by Julius Capitolinus] a similar eclipse occurred, which, according to ancient reports, happened a short time after the Olympian Games A.D. 239. Hence the latter eclipse would have been that of A.D. 239, Aug. $16^d\ 2^h$, which eclipse was a partial one." Now if the writer had referred to some ancient authority, we could have examined this question; but the expression "according to ancient reports" is so indefinite that it is impossible to base any argument upon the passage. Prof. Stockwell's contention that the large eclipse (at Rome) of A.D. 240 rather than the smaller one of 239 is meant, assumes that the writer when he wrote "two years" meant "three"; and his idea that A.D. 239 was a year of an Olympian festival is certainly erroneous. With regard to Boetticher, his agreement with Prof. Stockwell is not so great as the latter supposes, according to whom the 255th Olympic festival occurred in A.D. 240, which would make the 257th fall in A.D. 248 and the 261st in A.D. 264, whereas Boetticher places these in A.D. 252 and 268 respectively. Nor is Boetticher consistent with himself; for on p. 31 ('Olympia das Fest und seine Stätte,' 2nd edition) he speaks of A.D. 395 a[illegible] the date of the last Olympic festival, shortly before (he says tw[illegible] years, but Theodosius the Great died in January of that year, an[illegible] the invasion took place towards the end of it) the irruption of t[illegible]he Goths into the Peloponnesus under Alaric. Two years bef[illegible]re that was A.D. 393, which was probably really the date of t[illegible]he Olympic festival. Idatius mentions that an eclipse of the S[illegible]un took place on the third day before the ides of November in [illegible]the eighth year of the reigns of Arcadius and Honorius; and ther[illegible] is little room to doubt that this was the eclipse of the 11th [illegible] of November, A.D. 402. If Prof. Stockwell would determine the circumstances of this eclipse from his data it would, I feel s[illegible]re, be very interesting, and a confirmation of the date of the deat[illegible] of Theodosius.

It may be worth while here to point out that Socrates, the ecclesiastical historian, is evidently wrong in some of his Oly[illegible]pic dates, for they are inconsistent with each other. Thus, he [illegible]ays that Constantine the Great died in the second year of the 278th Olympiad, and that Constantius II. reigned after his fat[illegible]er's death twenty-five years and died in the first year of the 2[illegible]5th Olympiad, which would be twenty-seven years after the for[illegible]ner date. The latter is probably correct, and corresponds to A.D. [illegible]61, when Constantius II. died on the 3rd of November. An Oly[illegible]pic festival therefore would have occurred in the summer of that y[illegible]ar; and it is probable that the last was held thirty-two years (e[illegible]ght periods) afterwards, in A.D. 393, soon after which the fur[illegible]her celebration of the games was prohibited by Theodosius the G[illegible]at, though dates were still from habit for some years reckoned according to the times when these would have been due.

Yours faithfully,
Blackheath, 1895, April 8. W. T. Lynn.

## *On Heis's T Radiants.*

Gentlemen,—

In 1891 I found from observations of shooting-stars a rich radiant in R.A. 0° and Dec. +6° (for October 7). This appears to be connected with Heis's T radiants. His results are:—

| Approximate date. | R.A. | Dec. | Long. | Lat. |
|---|---|---|---|---|
| Sept. 15 .... | 342° | + 9° | 347° | +17° |
| 22 .... | 0 | 12 | 5 | 11 |
| Oct. 3 .... | 359 | 17 | 6 | 16 |
| 24 .... | 1 | 15 | 7 | 13 |
| Nov. 7 .... | 1 | 15 | 7 | 13 |
| 22 .... | 3 | 26 | 14 | 23 |
| Dec. 20 .... | 3 | 17 | 10 | 14 |
| Mean: Oct. 25 .... | 358½ | +16 | 5 | +15 |

For Sept. 15 I obtain the following elements: ☊ 352°, $i$ 14°, $\pi$ 69°, $q$ 0·62; from the mean: ☊ 32°, $i$ 7°, $\pi$ 79°, $q$ 0·84, and for Dec. 20: ☊ 88°, $i$ 4°, $\pi$ 95°, $q$ 1·00. Both the approximate constancy of the latitude and of the perihelion longitude (with small inclination) indicate that the radiants belong to a system probably connected with the tail of some comet. For the coordinates of the aphelion I find from the three orbits respectively: long. 248°, lat. −13°; long. 259°, lat. −5°; and long. 275°, lat. 0°. These are sufficiently close to each other to merit attention, although an ephemeris constructed on the basis of the mean position does not represent the observations within their probable errors. From my own radiant I obtain ☊ 14°, $i$ 4°, $\pi$ 81°, $q$ 0·69. Further observations are required to ascertain the exact date when the shower is richest, and thereby the longitude of the node. This element it is most difficult to ascertain for shooting-stars. When that is settled the other elements are usually determined without ambiguity. This swarm of shooting-stars moves in a direct motion, and forms a rather small angle with the Earth's orbit. From the different perihelion distances obtained it may be surmised that its thickness is considerable.

Yours truly,
Hongkong Observatory, 1895, Feb. 6. W. Doberck.

## *Comet* I. 1894.

Gentlemen,—

In quoting Dr. Lamp's reference to the suggested connection between Brorsen's Comet and I. 1894, it is stated of the latter ('Observatory,' No. 226, p. 171) that "it returns to perihelion about 1901 August 2, and the question whether it is a fragment of Brorsen's Comet should then be set at rest." It may be as well to point out, however, that if the comet returns at the period stated it will not admit of observation, as it will be placed on the opposite side of the Sun to the Earth, and separated from us by an interval of about 200,000,000 miles. At this distance it would certainly be invisible in a dark sky in the largest telescope. even if it were not obliterated in the glare of the Sun's rays, When last seen on June 5, 1894, in the great refractor at Nice, its distance from the Earth was about 138,000,000 miles, according to the ephemeris by Wendell published in 'Astronomy and Astro-Physics' for June 1894.

Lamp, Schulhof, and Hind independently assign the comet a periodic time of about 7½ years, and it should be very favourably visible at alternate returns, as in January 1909 and 1924. The longitude of the comet's perihelion being 130½°, about 14,000,000 miles outside the Earth's orbit, it is evident that as the Earth is in longitude 130½° on January 30, only the winter perihelia of the comet may be successfully observed. In 1909 Jan.–Feb., if the computed period of 7½ years is well maintained, the Earth and comet will be on the same side of the Sun and comparatively near each other, so that the very favourable apparition of 1894 will be repeated. From the relative positions of Jupiter and the comet the former is not likely to exert much influence upon the comet before the return of 1909, when it ought to be visible for 5 or 6 months. But the return of 1924 is more doubtful, as the comet will probably experience disturbance from Jupiter in the years about 1912 and 1913.

It was unfortunate that the comet was not discovered until March 26, 1894, when it was already 45 days past its perihelion. I had swept a few degrees below the comet just before midnight on March 2, when its great altitude enabled it to escape. At the time I first saw it on March 26 it was due south and 71° above the horizon.

Yours faithfully,

Bristol, 1895, April 6. W. F. DENNING.

## *Variable Orange Stars.*

GENTLEMEN,—

If I may again trespass on your space, I should like to say a few words in reference to Mr. Backhouse's letter of March 19. I agree with him in thinking that stars, while varying in magnitude, may vary also in colour, white stars of course excepted. For example, the well-known variable, Mira Ceti, has this winter, according to my own observations, passed by gradual stages from red to orange. I find the following notes in my book:—

| | | | | | |
|---|---|---|---|---|---|
| 1894 Nov. | 3. | Red; 9 mag. | 1895 Jan. | 1. | Orange-red; 6, 5, or 7 mag. |
| „ | 15. | Very red. | „ | 8. | The same; 6,5 mag. |
| Dec. | 4. | Red. | „ | 18. | Rich orange; 6 mag. |
| „ | 18. | Red; 8 mag. | | | |

I do not think it has been sufficiently pointed out that the fainter the star the redder the colour. The term red cannot of course, strictly speaking, be applied to any star, since all contain some admixture of yellow; but there is as much difference between a red and an orange star as between an orange and a yellow one.

The observation of star-colours is undoubtedly beset with many difficulties, the greatest arising from the fact of personal equation. Mr. Franks, when Director of the Coloured Star Section of the British Astronomical Association, endeavoured, and did succeed, by taking the mean of a great number of observations by different observers, in establishing a standard for star-colours down to stars of the 5th magnitude, which might, he hoped, be available for future observers. Our present Director has, to my regret, decided to introduce a different nomenclature. It may be more simple, but it must certainly have the effect of invalidating past observations and destroying their continuity unless by the laborious process of translating one code into another.

Further Barton, Cirencester,
1895, April 8.

Yours truly,
E. Brown.

---

Gentlemen,—

I believe that the difficulty Miss Brown has experienced in identifying stars described in lists of such objects as "red" or "orange" is susceptible of explanation on the simple assumption of idiosyncrasy, without supposing that any actual change of colour has taken place in them at all.

It is, I believe, generally recognized that metallic specula give redder images of stars than either silver-on-glass mirrors or achromatic object-glasses; but, setting this aside altogether, I am certain that some people's eyes are so constituted as to tinge nearly every star with a more or less orange hue. This peculiarity may have its origin either in the vitreous or aqueous humour of the eye or in some abnormal condition or development of the rods and cones; but experience has shown me that it must and does exist.

I have before told, on more than one occasion, how when my friend Mr. G. F. Chambers was compiling the catalogue of red stars for one of the earlier editions of his invaluable 'Handbook of Astronomy,' he spent a night with me in my observatory for the purpose of going over certain of these objects which he had marked for examination; and how he and I (both men of normal colour-vision) entirely failed to detect a trace of redness, or even any faint orange tint, in a considerable number of them.

This opens a curious physiological question; and it would be interesting if some of those who see numerous red stars in the sky, were to have their eyes tested by some such apparatus as that so ingeniously devised by Captain Abney.

Forest Lodge, Maresfield, Uckfield,
1895, April 10.

Yours faithfully,
William Noble.

## OBSERVATORIES.

Stonyhurst.—We have received Father Sidgreaves' publication for 1894, which consists chiefly of the magnetical and meteorological observations made at Stonyhurst and at St. Ignatius' College, Malta, given here in the usual neat and comprehensive form; but the short introduction contains some notes on the astronomical work of the year which will be found of interest.

The measurement of the height of the solar chromosphere, formerly a feature of the work of this Observatory, has been discontinued, owing to the unsuitability of our climate for this work. Father Sidgreaves says: "the average length of the chromospheric line C appears to be as much a measure of the transparency of our atmosphere as of the depth of the solar chromosphere." This work is carried on under much more favourable conditions by Prof. Tacchini at Rome.

The drawings of sun-spots and faculæ have been continued as before. The discussion of these relative to the Wilsonian theory of "Cavities" has lately been brought to public notice.

The stellar work with the Perry-Memorial objective has been chiefly experimental. Many trial photographs of star-spectra have been taken with the photo-spectrograph. The report says:—"The photographs have been from the beginning stronger and have extended further into the violet end of the spectrum than was possible with the 8-inch glass: but it is only recently that the sharpness of the definition has been brought up to match the delicate markings on the photographs given by the old objective"; but Father Sidgreaves goes on to say that he was prepared to find this comparative loss of definition, owing to greater aperture and longer focal length in conjunction with his method of photographing without a slit.

## PUBLICATIONS.

The Elements of the Four Inner Planets and the Fundamental Constants of Astronomy. By Prof. Simon Newcomb.—In the preface to this book Prof. Newcomb says:—"The diversity in the adopted values of the elements and constants of astronomy is productive of inconvenience to all who are engaged in investigations based on these quantities, and injurious to the precision and symmetry of much of our astronomical work..... The longer this diversity continues the greater the difficulties which astronomers of the future will meet in utilizing the work of our time." Everyone engaged in astronomical work must be more or less conscious of this, and appreciate the importance of the work of forming a new system of planetary tables in which the same masses of the planets are employed throughout, on which

Prof. Newcomb has been engaged since 1877, when he became superintendent of the American Ephemeris. The work is now completed as far as the fundamental constants and the elements of the planets from Mercury to Jupiter are concerned. The present short volume contains a highly interesting account and summary of it.

In all 62,000 meridian observations of the Sun and the planets Mercury, Venus, and Mars were used. These include the Greenwich observations from 1750–1892, the Paris observations from 1801–1889, and the observations of 11 other observatories for shorter periods. These were all reduced to the same system of Right Ascensions and Declinations, sometimes by merely applying constant corrections, sometimes by completely re-reducing the observations. The observations were compared with the places derived from Leverrier's Tables, or rather from a provisional theory based on Leverrier's, but uniform values of the masses being employed throughout.

Each observation of a planet furnishes an equation of condition for correcting the elements of that planet's orbit and of the Earth's orbit. The observations of a few years are grouped together, and what Prof. Newcomb calls "partial" normal equations are formed from these. Combining all the "partial" normal equations, normal equations are finally obtained for the corrections to the elements in question for 1850 and to their secular variations. Corrections to the elements of the Earth's orbit for 1850 and to their secular variations are also obtained from the solar observations. Prof. Newcomb found, what is a very interesting fact, remembering the possibility of systematic errors in observations of the Sun, that the elements of the Earth's orbit were determined with considerably greater precision from these than from the observations of the planets. The correction to the adopted Right Ascensions of the clock-stars is, however, as would be expected, better determined from the observations of the planets.

In addition to meridian observations, use was made of the observations of the transits of Mercury and Venus across the Sun's disc, and considerable weight was attached to them, especially to those of Venus.

The results derived from separate planets and from the Sun are combined to obtain definitive values of the corrections to the adopted system of Right Ascensions and Declinations, and to the elements of the Earth's orbit. Substituting these in the equations, the values of the elements and of their secular variations are found for the other planets.

From the secular variations of the elements the masses of the planets could be obtained, "were it quite certain that these arise only from the masses of the known planets." The motion of the perihelion of Mercury cannot, it is well known, be explained by any admissible values of the masses of the disturbing planets. It is therefore necessary to obtain the masses independently of the secular variations. The methods of obtaining the mass of Jupiter are discussed and a definitive value adopted from them. The mass of Mars adopted is Prof. Hall's, derived from observations of the satellites. The mass of the Earth cannot be derived satisfactorily from the periodic inequalities it produces in the other planets, because of the possibility of systematic error in the observations dependent on the relative positions of the Earth and planet. It is consequently derived from the ratio of the solar and lunar parallaxes. The mass of Mercury is found by Prof. Newcomb from the periodic inequality it produces in the motion of Venus; that of Venus from the periodic inequalities it produces in Mercury and the Earth, Mars not being used, in consequence of a defect in its theory.

The secular variations corresponding to these masses are computed and compared with the results obtained from observation. The motion of the perihelion of Mercury, of the node of Venus, of the perihelion of Mars, and the change in the eccentricity of Mercury show discordances, considerably larger than their probable errors. Prof. Newcomb considers several hypotheses which have been suggested as possible explanations, especially Prof. Asaph Hall's that gravitation towards the Sun is not exactly as the inverse square of the distance. On this assumption the motion of the perihelia can be set right, and the other elements are not affected. Leaving the motion of the perihelia out of account, Prof. Newcomb now determines what masses will best satisfy the rest of the observed secular variations. The masses found for Mercury, Venus, and Mars are satisfactory, but for the Earth a mass is found which implies the value 8″·759 of the solar parallax. The smallness of this value leads Prof. Newcomb to discuss the different values found for the solar parallax. As the mean of seven different methods he obtains 7″·797, but all the other methods agree in giving a considerably larger value than that derived from the secular variation. This value, it should be remarked, depends mainly on the motion of the node of Venus. The question is further discussed, and Prof. Newcomb concludes that "since, if there is nothing abnormal in the theory, the solar parallax is probably not much larger than 8″·780, while if there is anything abnormal it is probably as large as 8″·797 or 8″·800," he will adopt 8″·790 as the basis of his tables—that is to say, a compromise is made between the value given by the secular variations and by other methods. For the mass of Venus he takes 1 ÷ 408,000, and for that of Mercury 1 ÷ 6,000,000. He also decides to increase the theoretical motion of the perihelion for each planet by the same small fraction of the mean motion. This is in accordance with Prof. Hall's hypothesis, and is adopted by Prof. Newcomb, as it is a very simple correction and represents the observations.

Taking these definitive values of the masses, the values of the secular variations are computed and substituted in the normal equations previously derived. In this way definitive values are assigned to the elements of the planets Mercury, Venus, the Earth, and Mars for 1850 Jan. 0, Greenwich Mean Noon.

In this brief account it has only been attempted to give in outline the scope and object of Prof. Newcomb's book, and no mention has been made of many important points on which it throws light. The work is one of the highest importance, for it is a thorough discussion of practically all the observations of the Sun, Mercury, Venus, and Mars; and its importance is increased still more when it is considered as the basis of and the key to the planetary tables which Prof. Newcomb has in hand.

F. W. Dyson.

---

Smithsonian Geographical Tables.—In 1852 the Smithsonian Institution published a series of tables intended for the use of Meteorological observers. These tables, known as Guyot's, have been so much in demand that in 1884 a fourth edition was issued. This edition soon became exhausted, and S. P. Langley, the Secretary, came to the conclusion to publish the work anew in three separate parts, viz.:—Meteorological, Geographical, and Physical, "each representative of the latest knowledge in its field, and independent of the others; but the three forming a homogeneous series."

The Meteorological Tables were issued in 1893. The present volume, which forms the second of the above-mentioned parts, has been prepared by Prof. R. S. Woodward, formerly of the United States Coast and Geodetic Survey, but now of Columbia College, New York, and is really a new work.

The scope of the work will be understood by inspection of the following summary of contents: Useful Formulæ; Mensuration; Units; Geodesy; Astronomy, Theory of Errors, and Explanation of the Tables, which are as below:—

Conversion—weights and measures.

Values of reciprocals, squares, cubes, square roots, cube roots, and common logarithms of natural numbers.

Circumference and area of circle in terms of *d*.

Natural tangents and cotangents.—Traverse table.

Log. meridian radius of curvature in English feet.

Log. of factors for computing differences of latitude, longitude, azimuth, in secondary triangulation.

Lengths of terrestrial arcs of meridian.

Coordinates for projection of maps—various scales.

Areas of quadrilaterals of Earth's surface of various extents.

Lengths of degrees of parallels of latitude.

Acceleration of gravity, and various other tables, amounting in all to 42.

These tables, which will probably be found useful by many persons, form part of vol. xxxv. of the Smithsonian Miscellaneous Collections, but may be bought separately.

## NOTES.

We owe M. Nyrén an apology. He has been good enough express a wish that nothing further be said on the matter, but some words of his have inadvertently been quite misrepresented these columns, we hope it is not yet too late to make reparatio The mistake occurred as long ago as our last January number, a the apology is due for the delay in rectifying it—a delay caus by a number of circumstances, some of which (viz. the illness one of the editors and the loss of a letter in the post) we beyond our control. The important point, however, is to have t matter set right; and without further explanation we beg to c attention to the following *erratum*. In M. Nyrén's letter in o January number, wherein he replies to a criticism by W. G. T. the Poulkova Vertical-Circle observations, occurs the followi passage:—

"…. it has never been established as a principle at Poulko to collect, for a catalogue position, an excessive number of obse vations. The gain of such a number, as long as we have t conviction that all the sources of systematic errors are eliminate seems somewhat problematic."

As it stands, this sentence apparently advances a rather startli claim for the Poulkova observations—a claim of conviction th they are free from systematic error. M. Nyrén himself must ha been startled on reading the words; and he wrote off at once point out that the word "*not*" had been omitted. It is clear tha even at this late hour, such an important misconception should removed; and it will be perhaps some compensation for the del if we can make the mistake quite clear. We therefore re-wri the sentence as it should be, viz.:—

"The gain of such a number, as long as we have *not* the co viction that all the sources of systematic errors are eliminate seems somewhat problematic."

M. Nyrén indeed wished to emphasize the fact that, althou the Poulkova Vertical-Circle observations were exceptionally fr from such errors, he by no means regarded them as entirely free

At the same time he pointed out two other mis-renderings his words in the same letter, though these being of minor impor ance, we do not further refer to them, in deference to M. Nyrén wish that too much should not be made of the matter. We a glad to think that he has acquitted us of any deliberate intenti to disregard any corrections which he might deem necessary.

---

Comet Notes.—Ast. Nach., No. 3281, contains an investigati by Signor Peyra of the definitive orbit of Comet 1893 IV. (Brook 154 observations are available, extending from 1893 Oct. 17 1894 Jan. 8, and made at 26 different observatories; of the 21 were made at Greenwich. The final elliptical orbit is follows:—

T=1893 Sept. 19·25954 Berlin M.T.

| | | |
|---|---|---|
| π ...... | 162° 22′ 19″ | 1893·0. |
| ☊ ...... | 174 55 12 | |
| *i* ...... | 129 50 14 | |
| log *q* .... | 9·909551 | |
| *e* ...... | 0·9964886 | |
| Period .. | 3516 years. | |

The quantity π has a probable error of nearly 3′, the observations not being suitable for its accurate determination.

It will be remembered that the resemblance of the orbit of this comet with those of 1864 I. and 1822 I. was early pointed out. Identity, however, is not possible, and this merely offers another example of a series of comets travelling in almost identical orbits.

The following search ephemeris of Comet 1889 V. is by Mr. Charles Lane Poor (Ast. Journ., No. 340):—

| | R.A. h m s | S. Decl. ° ′ | | R.A. h m s | S. Decl. ° ′ |
|---|---|---|---|---|---|
| May 2.... | 15 31 24 | 23 48 | May 26.... | 15 12 37 | 23 0 |
| 10.... | 25 17 | 23 35 | June 3.... | 6 43 | 22 40 |
| 18.... | 18 55 | 23 19 | 11.... | 1 33 | 22 18 |

There is a probable error of 2ᵐ in R.A., 12′ in Decl. The comet will be exceedingly faint and beyond the reach of ordinary telescopes.

Referring to the identity of Comet 1894 I. with Brorsen's Comet, it will be seen from a letter by Mr. Denning on another page that the return in 1901 will be very unfavourable for observation, and that the comet will probably not be again seen till 1909.

A. C. D. C.

---

Minor Planet Notes.—The planet BV discovered by Wolf on March 15 proves to be identical with (203) Pompeia.

The following planets have been recently named:—

| Number. | Discoverer. | Date of discovery. | Name. |
|---|---|---|---|
| 318 | Charlois. | 1891 Sept. 24. | Magdalena. |
| 319 | „ | Oct. 8. | Leona. |
| 331 | „ | 1892 April 1. | Etheridgea. |
| 336 | „ | Sept. 19. | Lacadiera. |
| 384 | Courty. | 1894 Feb. 16. | Burdigala. |

There is an article by Gen. Parmentier in the 'Bulletin of the Astron. Soc. of France' (March) on the distribution of the orbits of the first 390 minor planets. The three planets with smallest mean distances are: (330), dist. 2·09; Brucia, dist. 2·16; Medusa, dist. 2·17. The three with greatest mean distances are: (380), dist. 4·68; Thule, dist. 4·26; Hilda, dist. 3·95. There are very well-marked gaps at distances corresponding to ½ and ⅓ of

Jupiter's period, and a less strongly marked one at $\frac{2}{5}$ of the sam period. But gaps that were formerly noted at distances corresponding to $\frac{4}{7}$ and $\frac{3}{7}$ of Jupiter's period have been filled up b recent discoveries. The greatest density of the group is at mea distance 2·80, exactly that given by the law of Bode or Titius Ceres, Pallas, and Juno are all at about this distance from th Sun. 383 of the 390 orbits discussed have mean distances betwee 2·16 and 3·48. A. C. D. C.

THE DIAMETER OF NEPTUNE.—Following up his observations o position of the Satellite of Neptune made at the oppositions o 1892–3 and 1893–4, Prof. E. E. Barnard during the past winte has continued the series of measures with the 36-inch Lick equatorial, using generally a power of 520, which he think is more satisfactory than a higher power, as the effect of th wind is less perceptible. Measures of position-angle and distance were made with the filar micrometer on 14 nights, the results of which are published in Ast. Journ., No. 342. Prof. Barnard also took the opportunity on ten of these nights to measure the diameter of the planet, using for this purpose a power of 1000, which was found high enough to give a measurable disk, but not so high that bad seeing often prevented measurement. It will be noted that measures of diameter were not possible on every observing night. The mean of the results of the ten nights gives the diameter of Neptune as seen from the Sun, the planet being at its mean distance 30·0551, equal to 2″·433, corresponding to a linear diameter of 32,900 miles. The latest previous determination of this quantity was by Dr. H. Struve, and gave 2″·197. The mean of various determinations between 1846 and 1872 gave 2″·611.

A NEW FORM OF ZENITH TELESCOPE.—There have been many suggestions for the construction of apparatus to measure the zenith-distance of stars close to the zenith by simple micrometer measurement. An apparatus for this purpose is described by M. L. Fabry in the 'Bulletin Astronomique.' Briefly stated, the plan is this. A horizontal telescope is directed to a plane sheet of glass placed at an angle of 45° above a mercury-trough. The wires in the telescope eyepiece being made to coincide with their image reflected first from the glass to the mercury, and then back by the same path, the position of the zenith is marked. At the same time the light from a star near the zenith which passes *through* the glass plate is reflected from the mercury upwards to the glass and thence back to the telescope. There is thus an image of the star and the zenith in the field of the telescope, the distance separating which can easily be measured. This is the bare outline of the method. M. Fabry gives a variation of this which obviates the passage of the star-light through the glass and its reflection from the mercury, and also a plan to correct for want of parallelism of the faces of the glass plate; but these last-mentioned points indicate causes which would probably militate against the practical use of this apparatus.

---

The Application of Instrumental Corrections to Transit Observations.—Doubtless the method of applying azimuth and level corrections to transits by the formula $n \tan \delta + m$, where $n = L \cos c - A \sin c$, $m = L \sin c + A \cos c$, L and A being respectively the level and azimuth errors, $c$ the co-latitude of the observatory, and $\delta$ the declination of the star, is well known. It formed the subject of a correspondence in these pages some years ago. The geometrical meaning of the quantities $n$ and $m$ has been recalled to our mind by M. Périgaud's treatise in the volume of 'Paris Observations' for 1887, noted in our last number, where the geometry of this method is investigated. In the ordinary system we regard a transit instrument as being displaced by small rotations about two axes. Level error is caused by a rotation about the line where the meridian intersects the horizon. Azimuth error is the result of a rotation about a vertical axis. The rotation about the third axis is the free movement of the instrument. The method above mentioned similarly considers the displacement made by two rotations, but different axes are used. The quantity $n$ measures a displacement by rotation about the line in which the meridian intersects the equator; and a rotation about a line in the meridian passing through the pole—the polar axis it might be called—is measured by $m$. It is easily seen from this why the correction $m$ is constant for all stars, and it is only a little less obvious why the factor of $n$ should be $\tan \delta$. Considered in this way it is curious why the method should not have found its way into the text-books, as well as the ordinary system. The ease with which the corrections are applied by this "equatorial" method is much in its favour.

---

We would draw the attention of double-star observers to the fact that observations of 4 Aquarii (Σ 2729) at the present time will be of value. Dr. See has determined a provisional orbit, which gives:

| | | | |
|---|---|---|---|
| P.... | 126·65 years. | $\tau$ .... | 1899·88 |
| $e$ .... | 0·543 | $i$ .... | 68°·5 |
| $a$ .... | 0″·7036 | ☊.... | 177 ·4 |
| $n$ .... | +2·842 | $\lambda$ .... | 74 ·3 |

The residuals are large but the object is difficult, and Dr. See says that as the motion is now relatively rapid the distance will diminish.

The recent measures are:

| | | | |
|---|---|---|---|
| 1892·80 ...... | 181°·7 | 0″·33 | Comstock. |
| 93·81 ...... | 182 ·4 | ·35 | Comstock. |
| 94·86 ...... | 186 ·5 | ·38 | Schiaparelli. |

---

We have received a copy of vol. i. no. 3 of the publications the youngest of the Astronomical Societies, the Astronomi Society of Wales, whose headquarters are at Cardiff, and of wh Mr. Arthur Mee is President. This is a diminutive volu neatly and carefully prepared, and contains, as one expects of Journal of a Society, mainly the account of the monthly Meeti with abstracts of the papers read. "Other Worlds than Ours" written of in a judicial manner by the Rev. A. J. Jenkins. Mr. E. Southall contributes a concise instructive note on "the Ethe and there are others. A remark in a note on "Earthshine on Moon" we might quote: "To some folk the Moon 'on her ba is a sign of bad weather, though as a matter of fact this appeara is due to the inclination of her orbit to the equator, and of cou occurs at regular intervals." We think the author should h written "horizon" instead of "equator"; but it has often occur to us that the fallacious reasoning underlying this popular weat sign should be pointed out. The appearance of the Moon refer to *always* occurs at the equinoxes in these latitudes, and the Mo does not capriciously *turn on her back* at the approach of b weather, as the popular reading would suggest.

Legal Time in Canada.—Although the zone-time system bas on the Greenwich meridian has been in operation in Canada f many years, there has hitherto been no enactment making t time legal. An Act has recently been passed by the Onta Parliament which legalizes the time in use as the standard ti for the territory. The same Act also authorizes the use of t 24-hour time reckoning. That is to say, while not prescribi that the new system is to be used, the Act states that it shall equally valid from a legal point of view to count the hours fro 1 to 24 as from 1 to 12, with the abbreviations A.M. and P.M.

Zone-Time System.—As will be seen from a remark by Pr Geelmuyden on page 192, the universal zone-time system h received another adherent on the Continent, where Norway h adopted *mid-European Time* (one hour fast on Greenwich) sin the beginning of the year.

The bill for the introduction of mid-European time into Austri which has been before the Reichsrath for some years, it still n passed.

A Large Reflector for the Lick Observatory.—Prof. E. Holden asks us to make the following announcement:—M Edward Crossley, of Halifax, England, proposes to present to t Lick Observatory the 3-foot reflector and its dome which now for part of his private Observatory. The grateful thanks of the Li Observatory are offered to him for this most generous and high appreciated gift.

Messrs. Philip have favoured us with a copy of Mr. Elger's book on the Moon, which they have quite recently published. Many of our readers no doubt will be glad to have Mr. Elger's valuable notes in a collected form, and also a copy of his map, which can be had mounted and varnished, price 4 shillings. We hope to give a detailed notice of these next month.

We congratulate Dr. H. Struve on his appointment as Director of Kœnigsberg Observatory. At the same time it is sad to think that the great refractor at Poulkova will know him no more. He will leave Poulkova during this month (May) to take up new duties.

Visitation Day at Greenwich will take place this year on June 1st. The usual dinner will be held as of recent years at the Criterion, Piccadilly Circus.

It would seem that δ Cephei is to be placed on the list of spectroscopic doubles. Miss A. M. Clerke gives a graphic history of this star in the May number of 'Knowledge.'

The death is announced of Dr. Theodor Brorsen, who is well known as a comet discoverer. He was born in 1819, and was a prolific writer, principally on the subject of comets, of which he discovered five.

Errata.—In our report of the R.A.S. Meeting in last month's number, we inadvertently did Father Sidgreaves' paper a considerable injustice; on page 145, line 7 from bottom, for "less than half a year" read "less than half the number of years of Mr. Howlett's observations."

On page 173, in the account of the Solar Eclipse, for "$^{m}$ $^{s}$" read "$^{h}$ $^{m}$" in three cases.

---

## From an Oxford Note-Book.

In two papers recently communicated to the 'Comptes Rendus' (February 1895), MM. Deslandres and Poincaré appear to claim a step in advance which most of us thought had already been taken. When Doppler's principle is applied to a moving body which shines by reflected light, the displacement of a line in the spectrum is the sum of the displacements due to the motions relative to the source of light and the observer. This is surely not new? And yet a rather elaborate theoretical demonstration of it is given by M. Poincaré, as a note on some experimental researches by M. Deslandres on the planet Jupiter. The experiments are welcome; for he would be a bold man who would declare that any physical fact was sufficiently confirmed. But is M. Poincaré entitled to say "Les observations de M. Deslandres confirment ces vues théoriques, ce qu'on n'avait pas fait jusqu'ici;" ....? I have not been able to determine just how new the experiments ıy be, and, as already remarked, they are in any case welcome; t one would have thought that the necessity for the mathematical monstration of "ces vues théoriques" had long ago disappeared. ·rhaps a few quotations will best establish this point.

---

In the 'Times' of 1895 April 19 appeared an interesting letter Miss A. M. Clerke on "Saturn's Rings"; where she says of the locities of revolution of the small components: "These velocities ight very well be detected and discriminated spectroscopically by expert of Professor Keeler's quality, especially since the corre-onding line-displacements are doubled by the reflection of the ht in which they appear. They are produced as it were twice er."

The writer does not apparently consider it necessary to quote y authority for this statement. Nor was it any more necessary n years ago. In 'The Observatory' for 1885 (p. 118) Mr. aunder writes:—"The planet Jupiter, from the wonderful locity with which it rotates, affords another means of demon-rating this displacement to the eye. The difference of motion of e two limbs is more than 15 miles a second, and the effect of is difference is doubled by the fact that Jupiter shines by re-cted not inherent light."

Both these statements are general and do not profess absolute curacy. They are accurate only when the planet is in opposition source, reflector, and observer in the same straight line; other-se the displacement, though increased, is not doubled. An curate statement of the general case is given in a paper by of. Niven in the 'Monthly Notices' for 1874 (vol. xxxiv. p. 345). s regards experimental verification, I am not sure what measures ve been published, if any; but it is certain that Huggins tained photographs of the spectrum of Jupiter in 1878 in ıich the displacement can be clearly seen.

---

Astronomy generally, and the Royal Astronomical Society in rticular, have seldom had more devoted friends than the late rs. Jackson-Gwilt. Astronomy has always owed much to its ealthy amateurs, who have given freely of their abundance in her rvice; but there is Scriptural authority for estimating very ghly among such gifts the £300 presented by Mrs. Gwilt to e Royal Astronomical Society in 1860 for the foundation of a edal. The interest on the money was to be paid her for her etime, and this in itself is some indication of the magnitude of e gift to the giver. By her death the interest has recently ome available for its intended object, and the particular method ıwarding it is under consideration by the Council. But these facts have already been stated in these columns: the object of the present note is to remark on another legacy from the same source. Mrs. Gwilt has bequeathed to the Society her Astronomical Scrap-album, and it has lately been forwarded to Burlington House by her Executors. It contains a large variety of photographs, old pictures, newspaper-cuttings, &c., which are not only of great interest in themselves (especially some of the early photographs of distinguished astronomers), but also as showing the untiring devotion to our science of the collector. One cannot help regretting, with such evidence of devotion before one, that the proposal to name a small lunar crater after Mrs. Gwilt (which is recorded with obvious and deep gratitude in the album) was after all not generally accepted.

---

One of the illustrated monthly magazines is providing us with a series of pictures entitled "Guesses at Futurity." The guesses vary considerably in character with the subject, becoming wilder as the questions considered recede from the domain of everyday life. Thus, the "street-lighting" of the future is represented by a series of captive balloons throwing down strong beams of light after the manner of the already familiar search-light—a not impractical suggestion; but when the artist leaves such homely topics and deals with gold-mining, his speculations become wilder, and nothing less than the mountains of the Moon will satisfy him for the scene of his operations. I have not sufficient technical knowledge of the subject to know whether the depicted railway among the lunar mountains resembles those in actual use in Wales and other gold-mining districts, or whether it is a glorified form of such. The mining is apparently being conducted on the hither face of the Moon, for the crescent Earth is giving light and an "aerial car" is seen arriving with the future surplus population of this globe, which will apparently then be as eagerly seeking the Moon as its ancestors did Australia or California.

---

So long as we do not have too many of such phantasies, they are very welcome. We can pardon their scientific blunders for the sake of their suggestiveness and the amusement we derive from them. They are by no means a product of modern times; and not the least interesting are the speculations recorded by past generations, for we are in a position to judge of their value.

A couple of centuries ago a "glimpse of futurity" was sketched by Sir Francis Bacon in his 'New Atlantis.' It will not take long to glance at the astronomy which enters into his picture. "We have high towers," says the wise man of Atlantis, "the highest about half a mile in height, and some of them likewise set upon high mountains, so that the vantage of the hill with the tower is,

in the highest of them, three miles at least..... We use the
towers, according to their several heights and situations, for inso
tion, refrigeration, conservation, and for the view of divers meteo
as winds, rain, snow, hail, and some of the fiery meteors al
And upon them, in some places, are dwellings of hermits wh
we visit sometimes, and instruct what to observe." With a litt
license to interpret, what a wonderful forecast is this! Obser
that not only are mountain observatories foretold, but the placi
of "winds, rain, snow, and hail" before "the fiery meteor
suggests that such observatories will be instituted for meteo
ological before astronomical purposes; and thus we see why t
Ben Nevis Observatory was built before the Lick. Observe, agai
how all these phenomena are classed as "divers meteors." Is n
Bacon thus the originator of the "Meteoritic Theory" as well
the author of Shakespeare? But the clearest prophetic vision
to be discerned in the last sentence—"we visit the hermits som
times and instruct them what to observe." Herein we recogni
at once the Boards of Visitors of the observatories, and th
functions!

---

MOST of the scientific forecast in the 'New Atlantis' de
with medicine and chemistry; but there is one passage deali
with optics which is of sufficient interest to be quoted. It mu
be remembered that the telescope had already been invented, f
the date of writing is 1626; and it is surprising that so little
definitely said about it. The passage is as follows:—

"We have, also, perspective houses, where we make demo
strations of all lights and radiations, and of all colours; and o
of things uncoloured and transparent we can represent unto y
all several colours, not in the rainbows—as it is in gems a
prisms—but of themselves single. We represent, also, all mult
plications of light, which we carry to great distance, and make
sharp as to discern small points and lines. Also all colouratio
of light; all delusions and deceits of the sight, in figures, magn
tudes, motions, colours; all demonstrations of shadows. W
find, also, divers means yet unknown to you of producing of lig
originally from divers bodies. We procure means of seeing objec
afar off, as in the heavens and remote places; and represe
things near as afar off, and things afar off as near, making feign
distances.

"We have also helps for the sight, far above spectacles a
glasses in use; we have also glasses and means to see small a
minute bodies perfectly and distinctly, as the shapes and colou
of small flies and worms, grains and flaws in gems, which cann
otherwise be seen; observations in urine and blood not otherwi
to be seen. We make artificial rainbows, halos, and circles abo
light: we represent also all manner of reflections, refractio
and multiplications of visual beams of objects."

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

No. 228. JUNE. 1895.

## MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, May 10, 1895.

Dr. A. A. Common, F.R.S., *President*, in the Chair.

*Secretaries*: Prof. H. H. Turner, M.A., B.Sc., and
E. W. Maunder.

The Minutes of the previous Meeting were read and confirmed.

*Mr. Maunder.* 76 presents have been received since the date of the last Meeting. Amongst those calling for special notice is a copy, presented by the author, of Mr. Elger's new book on the Moon. Mr. Elger has long been known as a most zealous student of Selenography, and the work, which gives a full description of the physical features of our satellite, will undoubtedly be found a most useful addition to our library. We also have a series of photographic enlargements made by Dr. L. Weinek from negatives taken at the Paris Observatory; and a number of photographs have been presented by Dr. Sheldon, a Fellow of the Society. These are studies of portions of the Milky Way made with a Dallmeyer portrait-lens of 2⅝ inches diameter and 6¼ inches focal length. Dr. Sheldon's idea is to get a photographic record of the Milky Way that shall agree as nearly as possible with the picture seen by the eye as to the number of stars delineated. Dr. Sheldon also sends a photograph of the constellation of Orion showing the nebula which was recently discovered by Prof. Barnard. There is also a series of twelve pictures presented by Mr. Percival Lowell, made by photographing a globe showing Mars as it appears to him by eye observation. The results are certainly remarkable.

I might also mention as having been received a volume of Lund Observations, giving the results of meridian observations of stars in the zones + 35° to +40°, and also an extremely beautiful lanter slide presented by Mr. W. E. Wilson, showing the star-cluster i the constellation Hercules.

*Capt. Noble.* With regard to these photographs of the Mil Way, the most curious thing is, they are taken with an instrume moved by a clock which drives, I am given to understand, ve badly indeed, remembering the accurate clock-driving required f stellar photography. For the most part stars are kept in the proper position on the plate by moving the instrument by han and knowing that this is so, the pictures are wonderfully done.

*Mr. Maunder.* Dr. Sheldon says his clock will not keep on star for more than 2 secs. without guiding, and he has to expo for an hour or more. [The photographs by Dr. Sheldon, Mr. Elg and Mr. Wilson were here thrown on the screen.]

*Capt. Noble.* I should like to call attention to one thing wh is instructive. This photograph is taken by a portrait-lens, and will be noticed that stars at the centre of the field have circul images, whilst those near the edges of the plate become of t form of parallelograms. If the same thing takes place when person's portrait is being taken, it is easy to see that the likene is not likely to be flattering.

*The President.* I should like to make some remarks upon t photograph of the Milky Way, taken with a portrait-lens moderate aperture and 6 inches focal length. I have been waiti for some time past to see a photograph of the Milky Way wh would compare with the beautiful views taken by Dr. Boeddick at Lord Rosse's Observatory some years ago. There is no dou but that a photograph taken with a lens of focal length that is comparable with that of the eye differs enormously from that se by the eye. But a photograph taken with a lens of focal len from 8 to 10 inches does give such a representation of the sky is fairly comparable with a chart made from naked-eye observati and if we could take photographs of portions of the Milky W without that distortion to which Capt. Noble has alluded, and the pieces together, we should have the best possible representat of the galaxy. Such a work would be quite within the scope an amateur possessing limited astronomical means, and I sho be glad to see some one do it.

*Dr. Roberts.* I can supplement your remarks, Sir, by say that Dr. Boeddicker has been engaged for some years at Lord Ros Observatory in making a photographic chart of the Milky W with a camera of short focus such as you describe, which he be able to compare with his own hand drawings of the sa region.

*The President.* That is news to me, and I think that a p tographic view of the Milky Way made by Dr. Boeddic to compare with his charts will be very valuable. I will Dr. Roberts to read us his papers on photographs of nebulæ.

*Dr. Roberts.* The photograph of the nebula M 1 Tauri taken with the 20-inch reflector on 1895 January 25, the plate being exposed for one hour. The copy now presented is enlarged to the scale of one millimetre to 6″. Two enlarged photographs of the nebula taken with an exposure of 3 hours were presented to the Society in 1892 May, but the mottling and star-like condensations within the denser parts of the nebula are better seen on this picture. All the stars that are shown on the photographs of 1892 are also visible in this, and there are no obvious changes in position angles or in brightness of stars or nebulosity during the interval. The nebula as a whole is unsymmetrical in form and after careful study is suggestive of a state of great disturbance internally. There is a dark rift which forms almost a straight line in a direction *n.f.* and *s.p.* across the centre of the nebula. Another rift forms a triple curve along the north margin of the nebula and extends nearly its whole length. Notwithstanding the evidence we have of great disturbance affecting the substance of this nebula, it is impossible to say that any change has taken place in its structure during the interval of three years from now and the time when the first reliable records of its form and internal details were made. But I am not surprised at this, for having compared the photograph of the great nebula in Orion, taken in 1886 October, with that of the same object taken in 1894 February, an interval of 7 years 4 months, I have been unable to recognize any change in the structure, although the nebula appears to be in a state of violent commotion.

The photograph of the nebula near 15 Monocerotis was taken with the 20-inch reflector on 1895 Feb. 13, with an exposure of the plate during 3 hours, and the copy now presented is enlarged to the scale of one millimetre to 24″. References to the star and to the region round it will be found in the New General Catalogue, in Lord Rosse's observations, and also in 'Astronomy and Astro-Physics,' vol. xiii. pp. 178–182, where Prof. Barnard's observations are given. Prof. Barnard has sent to this Society a positive copy on glass of his photograph taken with a portrait-camera of the region surrounding 15 Monocerotis, and a lantern-slide has been made from it to the same scale as that of the photograph I have just shown you, and from this you will at once recognize the vast difference between a photograph taken with a small camera and one taken with a comparatively large reflector. The reflector photograph shows in detail the fine lines and curves of nebulosity, and the stars are far more numerous than they are on coincident areas of the camera picture. The discs of the stars on the photograph taken with the short-focus lens are enormously out of proportion compared with the discs on the reflector photograph, and these large discs very often cover near stars while the larger instrument shows separately the components. There are areas on the camera photograph which most of us would accept as evidences of nebulosity, but it is not nebulosity at all. These appearances are caused by the small scale of the photograph showing

areas crowded with stars as if they were nebulous, and the
rifts are areas with fewer stars in them.

*The President.* I should like to point out that in Prof. Barn
photograph we have all that is shown in that by Dr. Rob
which shows that after all there are advantages in using a w
angle lens of short focal length for getting pictures of t
delicate nebulosities. It is perfectly true that for photograp
the details of a nebula it is best to use a large focal length, b
get outlines of delicate nebulosity it is just as good to use a sl
focus lens and give a long exposure. So that to get a pictu
faint nebulosity shown over a large region such a telesco
Prof. Barnard's is very suitable, but an instrument of greater
length would be more suitable to photograph the delicate struc

*Dr. Roberts.* I am obliged to the President for his explanat
in reference to these photographs, but I think they will not
close examination; for instance, it is not probable that faint
would be shown on the reflector photograph and not appea
the camera photograph, whilst nebulosity fainter than those
is shown on the camera photograph and not on that taken b
reflector. Much of this apparent nebulosity is really due t
coarse granulation of the film being affected by the diffused
of the stars, which are very numerous and apparently
together, because of the smallness of the camera scale.

*The President.* There is this to be said about granulation,
the more sensitive the plate is, the coarser becomes the gr
lation.

*Prof. Turner.* Dr. Roberts has presented some of his beau
enlargements to the Society, and these may be handed round
am sorry to see that Lord Rosse has not been able to sta
remark on these, as the name of his father is inseparably
nected with the resolvability of nebulæ. Dr. Roberts has bro
an interesting question before us in comparing two photogr
one taken with a short and one with a long focus lens, and sho
that appearances are very different. Perhaps in the future som
will photograph these with a still larger telescope, and poss
then some of the beautiful photographs he shows us ma
corrected in the same points in which they correct Barnard's
do not know whether Dr. Roberts will accept this possibilit
the existence of such a third term, but I think we are all ag
upon the value of a comparison of photographs, which we kno
be so good of their kind, as those taken by Prof. Barnard on
one hand with his short-focus instrument and by Dr. Rob
again with his longer-focus telescope.

*Mr. Knobel.* In Lord Rosse's drawings of the nebula in Ta
there are a great many filaments from the "neck of the go
which are not visible in the photograph. In the small plane
nebula 46 M in Argo, Lord Rosse's drawing shows many
ments surrounding the circular annulus which are not visibl
Dr. Roberts's photograph. I have been puzzled about the

crepancy, and should be glad if an explanation could be offered. There is a very material difference between the photographs and Lord Rosse's drawings in the case of these nebulæ.

*Rev. W. Sidgreaves.* It seems to me that we have an explanation of the discrepancies found between drawings and photographs of celestial objects, suggested by the spectra of stars. The bright star of our present evening sky—Arcturus—gives a spectrum singularly deficient at the violet end, while others are equally wanting in the visual rays. The picture traced upon the retina of the eye may not be the same as that impressed upon the photographic plate.

I think Dr. Roberts has done a good service in the comparison he has made of the two photographs of the nebula in Taurus. We cannot be too much on our guard against unsound inferences either from eye observations or photographs of distant objects. Dr. Roberts has shown that the aggregation of false photographic stellar discs may give the plate an appearance of nebulosity which is unreal. But I could not follow him to his conclusion against the evidence of the American plate for the extension of the nebulous matter beyond the outlines of his picture; and I cannot help thinking that, with a longer exposure, Dr. Roberts's plate would, to the loss of its delicate details, have revealed the same extension of the nebula.

*Mr. Knobel.* I think granulation is most clearly shown. I was examining it recently, and there is no doubt about the coarseness of the granulation.

*Capt. Noble.* I should like to ask Dr. Roberts one question, and that is, upon what ground he bases his opinion that the nebula is in a state of violent commotion? There appear to be two holes through it—one circular and symmetrical,—and that does not look as if there was much irregular activity in the body.

*Mr. Chambers.* I should like to say a word on Mr. Knobel's point about the accuracy of the drawings of the elder Lord Rosse made in 1844. Since 1844 it has been several times observed at Parsonstown by the present lord, and there are records in his catalogue of 1888 which seem to imply on his part great distrust of these drawings. As far back as 1848 Nov. 29 there is this record: "Would have figured it different from the drawings in Phil. Trans. 1844"; in 1853 Dec. "appeared very different from drawings in Phil. Trans. 1844"; then, finally, "No trace of nebulous arms as on drawings of 1844." I think it seems to imply that the 1844 drawings must be considered altogether unreal and unsubstantiated.

*Dr. Roberts.* In reply to Capt. Noble's question as to why the opinion was formed that some of the nebulæ are in commotion, I would say that it is simply an inference, not a dogmatic opinion. If they were not in irregular movement we should have the symmetrical outlines seen in other nebulæ, such as in the spiral nebula in Andromeda and in many others which have rings around them and condensations in the centre but M 1 Tauri and the nebula in Orion do not appear to have assumed that symmetrical shape; hence the inference that they may be in a state of irregular commotion and undergoing a change to the symmetrical form.

Father Sidgreaves does not seem to have caught my statement as to the ratio of aperture to focal length in Prof. Barnard's camera and my reflector; it is practically the same in both instruments, one having an aperture of 6 inches and focal distance of 31 inches, and the other an aperture of 20 inches and focal distance of 98 inches. Now, the assertion that this compound lens has greater photographic power than the reflector cannot, if I may trust my past experience, be correct. The evidence obtained by close examination of the photographs just exhibited is clearly against the assumption, and, on many occasions during the past years, I have tested the relative photographic power of the reflector against various photographic camera lenses, with the uniform result that the reflector photo-effect was greater than that of the lenses. In the photographs now under consideration the exposures of the plates in both instruments were practically equal.

*Prof. Turner* read an abstract he had made of Prof. Barnard's paper on the "Variable Nebulæ of Hind and Struve in Taurus and on the Nebulous Condition of the Variable Star $\tau$ Tauri." The nebula near the star $\tau$ Tauri was discovered by Hind on October 11, 1852, and was an easy object for small telescopes. It was subsequently observed by D'Arrest, Struve, Lassell, and others; but on 1861 Oct. 3 it had disappeared from ordinary instruments, but continued to be observed by the great telescopes of Lassell and Struve until 1868, when it was not visible in the great Poulkova refractor, but in looking for it Struve found a nebula 4′ preceding the place, which is called Struve's nebula. This was subsequently observed by D'Arrest, who was sure that no nebula previously existed there. On November 8, 1877, Tempel saw Struve's nebula. It had disappeared by December 12, but Tempel saw two small stars in the place of the nebula, the northern of which he had seen *in* the nebula on November 8.

This region seems not to have been further observed until 1890, when Mr. Burnham found that $\tau$ Tauri was involved in nebulosity, and a paper on the subject is given in 'Monthly Notices R. A. S.' for December 1890. A part of the present paper is taken up with an explanation that Mr. Burnham erroneously supposed this to be Hind's nebula. On 1890 Oct. 15, at Mr. Burnham's request, Prof. Barnard examined this region and observed that $\tau$ Tauri was surrounded by nebula, and also picked up Hind's nebula, which was then extremely faint. On 1890 Nov. 1 Prof. Keeler found that $\tau$ Tauri was nebulous. On 1895 Feb. 25 Prof. Barnard thoroughly examined this region, and found that Hind's nebula, instead of being faint, as in 1890, was an easy object, but that there was no trace of nebula round the star $\tau$ Tauri. He sometimes seemed to see a nebulous glow, but nothing like the nebulous appearance of 1890. Further there was no nebula where Struve's nebula had been. He convinced himself of this on Feb. 25, and on Feb. 26 he measured Hind's nebula. On March 24 he suspected a faint nebula in the place of Struve's; Hind's nebula was so faint that it was hardly perceptible, and *T* Tauri was distinctly nebulous. Prof. Turner added that this was sufficient to show that there was considerable reason to think that these nebulæ are variable.

*The President.* I do not know whether the paper bears out a supposition which has just occurred to me, that when the Struve and the Hind nebulæ are absent there is a greater condensation round *T* Tauri, the change being apparently a shifting of brightness from one point to another. This is the first real case that has been observed, I think, of a change in a nebula.

*Mr. Newall* read his paper on "Micrometer Measures of Phobos, the Inner Satellite of Mars, during the Opposition of 1894." Micrometer measures of the distance and position-angle of this satellite with respect to the planet were made with the 24-inch refractor at Cambridge on six different nights in rather unfavourable weather during the autumn of last year. These measures were sufficient to show that the satellite was considerably late—between 9 and 11 minutes—on the ephemeris time as computed by Mr. Marth. This would seem to point to an error in the adopted periodic time or to a definite change in the period. It was not clear whether the period adopted in computing the ephemeris had been determined from observations at recent or earlier oppositions. Also it appeared that there was a distinct difference in the distances of the satellite from the planet at eastern and western elongations—a point which had also been established by Prof. Campbell from measurements made with the Lick equatorial.

*The President.* This inner satellite of Mars is a most delicate object. I remember seeing it soon after its discovery in 1877, and those who have seen it will appreciate the delicacy of the micrometer measurements that would give as result such a uniform curve as that which Mr. Newall has just shown us.

*Prof. Turner* then read a paper by *Mr. Stanley Williams* on the "Rotation of Saturn in 1894." Mr. Williams had made a series of careful observations, and found there was evidence that the rotation period of Saturn was different in different *longitudes*, not in different latitudes, as in the case of the Sun. He found among the dark spots on the surface of the planet three distinct groups—one with a rotation period of $10^h\ 14^m\ 58^s$, the next with a rotation period of $10^h\ 14^m\ 43^s$, and another with a period of $10^h\ 15^m\ 50^s$. The *bright* equatorial spots, on the other hand, had also three different periods. The first group had a rotation period of $10^h\ 13^m$, group B $10^h\ 12^m\ 40^s$, and group C $10^h\ 12^m\ 25^s$. These results were not entirely new. There was a paper last year by Mr. Williams, in which he gave similar results, showing that the rotation period did not seem to be the same in different longitudes of the planet There did not seem any theoretical reason for suspecting thes results. Prof. Turner had written to Prof. Darwin and to Prof Sampson on the subject, and received the following replies :—

Prof. Darwin writes :—"The Saturn results are certainly ver remarkable, and suggest a rather wild consideration. Is it possibl that the sections of Saturn parallel to the equator are not circular It is well known that there is a figure of equilibrium in the forn of an ellipsoid, and also that there is another ellipsoid in whic the form stands still in space while the fluid rotates; lastly, tha these may be combined into a Riemann's ellipsoid, in which th form rotates, and in which besides there is circulation. For heterogeneous planet there should be something analogous, but i any such case, of course, the inequalities of rotation should b such that the 360° should be divisible into four quadrants. expect no one has ever tried to find systematic differences betwee the various equatorial diameters, and probably micrometric measures would not be sufficiently delicate to detect such difference but it might be worth trying."

Prof. Sampson says that there may be a hydrodynamical expl nation of the observations, and he suggests such a one. Or, h says, the facts may be due to tidal waves. It appears from th observations that the surface is evidently in a state of most di turbed motion, and Mr. Williams's results may be a sort of stor chart of Saturn.

*Capt. Noble.* I remember that Mr. Williams gives, in h admirable little book on the planet Jupiter, an exhaustive series observations of the rotation-periods of the spots, both light a dark; but in that case the period was considered as varyi according to the latitude, which is a fairly intelligible thing. T idea of a variation depending on longitude is difficult to comp hend.

*The President.* There is no doubt that we are to some exte the slaves of habit, and we are so used to considering the latitu as the argument for determining the rotation-period from analo of the sun-spots, that we find it hard to realize a variation depen ing on longitude. No doubt we shall have some light thrown the subject when we see the paper in print.

*Mr. W. E. Wilson* then read a paper on the "Thermal Radiati from Sun-spots from Observations made at Daramona, Stree Co. Westmeath." After describing the apparatus employed i the experiments the author exhibited a diagram which showed t amount of radiation from a sun-spot on each day during the peri of his observations as a percentage, which was on the aver about 30, of the thermal radiation from the unspotted surface the Sun.

*Rev. W. Sidgreaves.* I have been wondering whether we m accept Mr. Wilson's observations of the constancy of spot-rac tion, when near to and when remote from the limb, as a confir tion of the elevated position of the umbra. If the umbra is so elevated there would be less loss of heat-radiation energy by passing through absorbing medium.

In connection with the supposed elevation of the umbra of a spot, I will mention, with the President's permission, the contents of a letter just received from Father Fényi, of the Kalocsa Observatory. He says that, having read Mr. Howlett's paper and my own upon the Sun-spot drawings and the Wilsonian theory, he has looked through his own collection of drawings, extending over 15 years, and has found a complete series of the great spot of June 1887, forming a perfect supplement to the drawings made at Stonyhurst. It may be remembered that the appearance of this spot at ingress when at 7″ from the E. limb was, as described in my paper, in favour of a mountainous form of the umbra, screening from view the further side of the penumbra, and leaving the near side well in sight. Father Fényi says that his drawings, made under the best atmospheric conditions, show that the spot was quiet on its way to the W. limb, and that, when at 7″ from it, its appearance was precisely the same as that observed at Stonyhurst at the same distance from the E. limb. He adds, and I agree with the remark, that the two observations, taken together, make up a clear demonstration that the "nucleus," or, as we call it, the "umbra," was in this spot an elevation.

*Rev. A. L. Cortie.* I think Mr. Wilson's observations bear out results obtained by Father Secchi, and they are very important in their bearing on the study of the solar sun-spot spectra. It is frequently stated by Professor Lockyer that the lines giving evidence of the dissociation of our elements at solar temperatures occur in sun-spot spectra, and hence it is presumed that sun-spots are among the hottest regions of the Sun. But from Mr. Wilson's results it would appear that the temperature of spots is lower than that of the rest of the disc.

*The President.* I think Lockyer says that the spots are caused by a downrush of cooled vapour. I hardly understood from the author of this paper whether he had measured the temperature in the neighbourhood of the spots.

*Mr. Wilson.* I have not measured any faculæ at all.

*Mr. Newall.* Did you determine what is the least amount of radiation the bolometer would detect?

*Mr. Wilson.* It is very sensitive.

*Mr. Newall.* I would ask Mr. Wilson whether he made any allowance for the radiation reflected by the air?

*Mr. Wilson.* No. There is practically no reflected radiation.

*Prof. Turner.* I would like to ask whether Mr. Wilson has stated, or if he will state, the evidence on which he arrived at his conclusions?

*Mr. Wilson.* I have given it in the paper.

*Prof. Turner.* And may we regard this as the beginning of an extended investigation as to the radiation from spots at various parts of the solar disc? which would be a most valuable contribution to solar astronomy.

*Mr. Wilson.* Yes; I hope to carry it on.

*Capt. John Steele.* After thirty-eight years of life in all climates I have come to the conclusion, and have endeavoured to show, that the Sun is not a body of incandescent heat, and that there is no more heat in the Sun than there is in the Earth.

*The President.* Have you been in London during the last few days? (Laughter.)

*Capt. Steele.* I think we should look to see what the Sun really is. We do not ask what he is; we assume he is a body of incandescent heat.

The following papers were announced and partly read:—

*F. Valle.* "Observations of Minor Planets made at the Tacubaya Observatory."

*E. E. Barnard.* "On the variable Nebula of Hind and Struve in Taurus, and on the Nebulous condition of the variable star *T* Tauri."

*A. Stanley Williams.* "On the Rotation of Saturn in 1894."

*W. E. Wilson.* The Thermal Radiation from Sun-spots; Observations made at Daramona, Streete, Co. Westmeath."

*K. D. Naegamvala.* "On a Photograph of the Cluster 46 M."

*R. H. M. Bosanquet.* "On a Fixed System of Star Coordinates."

*Isaac Roberts.* "Photograph of the Nebulæ near 15 Monocerotis."

*Isaac Roberts.* "Photograph of the Crab Nebula M 1 Tauri."

*J. Gledhill.* "Observations of the Phenomena of Jupiter's Satellites, and the Transits of the Red Spot, Dark and Bright Spots, &c., at Bermerside Observatory, Halifax, during the winter of 1894-95."

*E. J. Stone.* "Answer to an Enquiry in the 'Bulletin Astronomique' for May 1895."

*H. F. Newall.* "Micrometer Measures of Phobos, the Inner Satellite of Mars, during the Opposition of 1894."

The following gentlemen were elected Fellows of the Society:—

*Andrew Russell Forsyth*, F.R.S., Sadlerian Professor of Pure Mathematics, Cambridge; *John Willoughby Meares*, Clive Hall, Shrewsbury; *William Willett*, Jun., The Cedars, Chiselhurst Common, Kent, and 2 Sloane Gardens, W.

The following Candidates were proposed for election as Fellows of the Society:—

*Antoine d'Abbadie*, Membre de l'Académie des Sciences, 120 Rue du Bac, Paris (proposed by G. H. Darwin).

*Loyal H. Bradford*, North Ferrisburgh, Vermont, U.S.A. (proposed by Lewis Swift).

*Oswald Thomas Tuck*, Naval Instructor, School Ship 'Conway,' Birkenhead (proposed by E. W. Maunder).

---

## BRITISH ASTRONOMICAL ASSOCIATION.

The sixth ordinary meeting of the current session was held at University College, on Wednesday, April 24, Mr. E. Walter Maunder, President, in the Chair.

*Mr. Petrie* read some correspondence from Mr. Walter Gale, Secretary of the New South Wales Branch of the Association, giving an account of the inaugural meeting of the branch, from which it appeared that 48 new Members had been elected and three others proposed for Membership. The Branch has already a membership of upwards of seventy.

*Miss Everett* read a paper by *Mr. E. E. Whitelow* on "Lunar Photographs." Mr. Whitelow's object was simply to promote a discussion, and had reference principally to the beautiful enlarged photographs presented by M. Prinz to the Association. He referred to the fact that the 36-in. telescope of the Lick Observatory had been put to the excellent use of producing a number of negatives of the Moon in the principal focus of the instrument, copies of which had been distributed among foreign societies and observatories. On the original photographs the Moon was about 6 in. in diameter, and the pictures were very rich in sharply defined detail. From these negatives Dr. Weinek, of Prague, had produced some extremely beautiful enlargements of small lunar areas; but it appeared that Dr. Weinek's pictures were not purely photographic enlargements of the Lick negatives, but were works of art. Mr. Whitelow thought that these productions were open to question, and their value must necessarily depend on the ability, knowledge, and trustworthiness of the maker. As scientific data for future reference they were necessarily in a different category from M. Prinz's mechanical reproductions. The writer added that notwithstanding the beauty and the value of the pictures of Dr. Weinek and M. Prinz, he was surprised at the fulness of the already published data as compared with these photographs, and how little that was new they showed over what the diligence of previous observers had secured to them.

*Mr. W. H. Wesley* said that Mr. Whitelow had made a rather serious mistake with regard to Dr. Weinek's photographs. They were by no means all of them "works of art," worked up or partly drawn by hand. Many were purely photographic enlargements, and it was a perfectly easy matter to distinguish the one from the other. The advantage of the photographs was, that whether they showed much or little detail, they were always comparable, while the best maps showed a most extraordinary difference in the po tion of details.

*The President* said he was glad that Mr. Wesley had call attention to Mr. Whitelow's mistake; the enlargements that I Weinek had presented to the Association were pure enlargemen altogether untouched. Dr. Weinek's object, in the method had adopted, was to get rid of the grain that a very high enlarg ment always brought up. Mr. Maunder then referred to thr enlargements of parts of the Moon presented to the Royal Astr nomical Society by MM. Loewy and Puiseux, of Paris, which thought completely distanced any other lunar photographs y produced.

*Miss Everett* announced that photographs of a region in t Milky Way, taken by Dr. and Mrs. Sheldon, had been receiv The idea kept in view in taking these photographs was not to t and obtain more detail than was visible to the naked eye. I Sheldon added that after completing the survey of a district, was intended to map it, taking as a basis these negatives a Mr. Marth's Catalogue.

The report of the Solar Spectroscopic Section for 1894 was th read, after which some slides of solar prominences of 1894, t lunar eclipse of March 10, 1895, and the recent solar eclipse, Mr. Newbegin, were shown; and a series of fifteen slides, ill trating a complete rotation of Jupiter, by Herr Leo Brenner.

*The President* gave notice that the next ordinary meeting, to held on May 29, would be followed by a special general meetir in order to discuss some proposed alterations in the rules of t Association.

## ROYAL METEOROLOGICAL SOCIETY.

THE monthly Meeting of this Society was held on Wednesd evening, May 15, at the Surveyors' Institution, Westminst Mr. R. Inwards, F.R.A.S., President, in the Chair.

Mr. G. J. Symons, F.R.S., and Mr. G. Chatterton, M.Inst.C. read a paper on "The November Floods of 1894 in the Tham Valley," which they had prepared at the request of the Council the Royal Meteorological Society. This consisted of a systema description of the causes which led to the great floods of Novemb last, and an analysis of the records obtained from the Tham Conservancy Board, from the Engineers of several of the tow along the river, and also from rainfall observers throughout Thames watershed. The information was given chiefly in form of tables, one of the first being a chronological history floods in the Thames Valley from the year 9 A.D. down to present time. This was followed by a short description of damage done in November 1894, which was illustrated by number of interesting lantern-slides. Details were then given of the levels reached at various places in all the principal floods from 1750 to the present time. The authors exhibited a map showing the relative elevation of all the parts of the Thames Basin, and then gave details of the rainfall for each day from October 23 to November 18, 1894. The results obtained by the Thames Conservancy Board showing the flood-levels at each lock were exhibited on a longitudinal section from Lechlade to Teddington, and the hydraulic inclinations from lock to lock were shown in a tabular form. The volume of flood-water, as gauged by the Thames Conservancy at Teddington, rose rapidly from 4000 million gallons per diem on November 12 to 10,250 million gallons on the 16th, 12,800 million gallons on the 17th, and to over 20,000 million gallons on the 18th, when the discharge reached its maximum. The last-named discharge is equivalent to 0·37 inch over the whole watershed of the Thames above Teddington Lock.

Mr. F. J. Brodie also read a short paper "On the Barometrical Changes preceding and accompanying the heavy Rainfall of November, 1894," from which it appeared that the latter half of October was characterized by unusually bad weather, especially in the more western and southern parts of the British Isles. The torrential rains of November 11 to 14, which actually caused the floods, were due to two secondary depressions which developed a certain amount of intensity as they passed over the southern part of England.

## *Prof. Keeler's Spectroscopic Observations of Saturn**.

THE hypothesis that the ring of Saturn consists of a multitude of small bodies revolving around the planet in circular orbits is an old one, but its universal acceptance dates from the publication of Maxwell's prize essay in 1859. While the mathematical proofs given by Maxwell and his predecessors are conclusive, a demonstration of the hypothesis by the widely different method of direct observation with the spectroscope is not, I think, without interest.

The proof recently obtained at the Allegheny Observatory depends upon an application of the well-known principle of Doppler, by which the motion of a heavenly body in the line of sight can be determinedby measuring the displacement of a line in its spectrum. Under the two different hypotheses that the ring is a rigid body and that it is a swarm of satellites, the relative motion of its parts would be essentially different; hence, to distinguish between these two hypotheses, it is only necessary to find a method of sufficient delicacy, in order to bring the quest within the province of the spectroscope. Any method depend on the successive comparison of the spectra given by differ parts of the ring would be almost certain to fail. The met which I have employed is explained below.

---

* As Prof. Keeler's observations and conclusions, which were first announced in England through the channel of the daily newspapers, have been to some extent misunderstood, we are pleased to be able to print an account of them written by himself for the American journal 'Science.'

If two planes, at right angles to each other, are passed thro the observer and the system of Saturn, one (A) passing anywh through the system and the other (B) through its centre, velocity, resolved in the direction of the line of sight, of any p on the surface of the system where it is intersected by plane can be expressed as a function of the perpendicular distance of point from plane B. It is only necessary to consider the when the plane A is parallel to the major axis of the appar ring. On the assumption that the ball of Saturn rotates a solid body, and the ring as an assemblage of particles, each which moves with a velocity determined by Kepler's third l the expressions for the ball and for the ring are very different, former being linear, and the latter an equation of a degree hig than the second. I have determined these expressions for special case above mentioned. They are still further simplified assuming that plane A also passes through the centre of planet.

Now, if we bring the image of Saturn, formed by a telesc upon the slit of a spectroscope, with the slit in the intersect plane A, the expressions above referred to are also (with app priate constants) the equations to the curves of which the lines the spectrum of the planet are a part, referred to an undispla spectral line and the perpendicular line through its centre as ax for, in these curves, $x$ is proportional to the perpendicular dista from plane B, and, by Doppler's principle, $y$ is proportional to velocity in the line of sight. The simplest case is, of course, t in which the slit coincides with the major axis of the ring; thi also the condition for which the differential velocity of points the surface of the ring is a maximum, and it is one which can approximately realized in observation.

Hence the laws of rotation of the component parts of system can be determined (within certain limits) by the *form* the special lines, and the form can be determined with very c siderable accuracy by photographing the spectrum with a suita instrument. The image of the planet must be kept very accurat centred on the slit-plate during the exposure *, in order to av the superposition of points having different velocities in the l of sight, and, for the same reason, the atmospheric conditi must be fairly good.

According to the assumptions which have been made above, which represent the accepted hypothesis, lines in the spectr of the ball are straight, but inclined; as compared with th direction, the general inclination of the (theoretically) curved lines in the spectra of the opposite sides of the ring is smaller, and it is *reversed*. The actual aspect of the lines on my photographs is in exact accordance with that required by the hypothesis.

---

* Two hours, in the case of the photographs taken at Allegheny.

If the ring rotated as a whole, the lines in its spectrum would be straight, and their direction would pass through the origin; they would be very nearly prolongations of the planetary lines. Such an aspect of the lines as this could be recognized on my photographs at a glance.

The direction of a line free from displacement was obtained by photographing the spectrum of the full Moon on the same plate, on each side of the spectrum of Saturn.

For further details, with the numerical results of measurement of the plates, I must refer to the May number of the 'Astrophysical Journal,' in which I have described these observations at some length. James E. Keeler.

Allegheny Observatory, Allegheny, Pa.

---

## *Algol.*

The peculiar circumstances of the variation of light of this star in the Head of Medusa are well known, but it may be not inexpedient to recall them here in this note, where it is proposed to collate some recent views and investigations concerning this system.

Algol, which in its normal condition is a star of the second magnitude, undergoes a variation of its light periodically, the length of the period being approximately 68·8 hours. For about 4 hours it loses light, and having then reached its minimum is seen as a star of the fourth magnitude, when it begins to regain its brightness and attains its normal appearance after a further period of about 4 hours. The star was known to be variable as far back as 1669, and in 1783 it was suggested by Goodricke, of York, as explanation, that the star was really a binary, one component of which was dark, and, as this passed by its orbital motion between the Earth and the bright star, partially eclipsed the latter, and so caused the variation. The subject was investigated by Prof. E. C. Pickering * in 1880, who from consideration of the observed period determined the relative size of the dark and bright components, and concluded that the time of orbital revolution was the same as that of the period of light-variation. This last fact was confirmed by the determinations of the motion of the bright star in the line of sight by the Potsdam spectrograph, which were perfectly consistent with the hypothesis of orbital motion; and further, Prof. Vogel † inferred from this observed orbital motion the sizes of the components, and that if they be of equal density the masses must be respectively four-ninths and two-ninths that of the Sun, and their distance apart 3,230,000 miles.

---

* Proc. Amer. Acad. vol. xvi. p. 17.

† Ast. Nach., No. 2947.

In writing above that the length of the period of the light variation was *approximately* 68·8 hours, the qualifying word was used advisedly, for it had been noted many years ago that this period is not constant. Argelander had shown that the time from minimum to minimum was a gradually decreasing quantity, and in 1888 Dr. Chandler, who is so well known for his success in resolving apparently irregular periods into orderly components, set himself the task of investigating the period of Algol. He showed that this quantity passed through all its changes of length in about 130 years, and this could be resolved into two component periods of 141 years and 37·7 years respectively, with a smaller variation superposed.

In 1892 Dr. Chandler, going one step further, advanced as an hypothesis to account for these periods that there is a third body of the system, a dark one, around which the two which make up Algol revolve in an orbit about the size of that of Uranus about the Sun, inclined at an angle of 20° to the line of sight, in a period of about 130 years. This hypothesis explains in a general wa the present observed shortening of the period from minimum t minimum, but Dr. Chandler fully admitted that it would no explain all the facts accurately; but he showed from a discussio of meridian-observations of the star that motion in an orbit suc as he assumed was not improbable.

This brings us within sight of the present date, and we come t recent researches on this interesting subject. In the 'Vierteljahrsschrift der astronomischen Gesellschaft' of 1894, M. Bauschinge investigated the meridian observations of the star, and cam to the conclusion that the proper motion, which Dr. Chandler ha taken as confirming his hypothesis, did not exist, and M. Tisseran (C. R. cxx. 3), adopting for the moment this view, sought fo another reason to explain the phenomena. His explanator hypothesis is this:—There is only one dark body, the orbit of thes two components is elliptical, and the form of the principal star i slightly flattened, which would cause a motion in longitude of th periastron of the orbit; and he goes on to show that this theor would very well account for a variation in the interval betwee minimum and minimum having a period of 140 years, and als would cause a variation in the *duration of minimum*, which, he say agrees with such variations recorded by Wurm and Schönfeld Prof. Lewis Boss now takes up the subject, and in the 'Astronomical Journal,' No. 343, writes as follows:—

"(1) M. Tisserand's hypothesis requires a periodic variation o large amount in the duration of the minimum phase of Algol: th question whether such variation in the required degree ha actually been observed, must undergo satisfactory examination.

"(2) On the other hand Dr. Chandler's hypothesis requires periodic inequality in the proper motion of Algol. It is evident that the tenability of this hypothesis does not rest upon the ability actually to recognize an inequality in the proper motion of Algol. Nevertheless the certain recognition of such an inequality would constitute the most conclusive and unanswerable element in the proof; it would establish the validity of Dr. Chandler's hypothesis."

Prof. Boss then proceeds to discuss the proper motion of Algol from observed positions from 1754 to 1895 on the assumption (1) of rectilinear proper motion, (2) of motion in an orbit, and concludes that the latter assumption better satisfies the data, and deduces the orbit. He summarizes thus: "The foregoing computation indicates that Algol revolves in an orbit of which the maximum calculated radius is five times its probable error; and the same computation indicates that the star passed the major axis of the apparent orbit within 3 or 4 years from the most probable date derived from the observations of Algol as a variable star." He concludes with the suggestion that it would be advisable for observers to give special attention to observations of position of this star, as the apparent orbital motion is, if the hypothesis be true, now only a little less than its maximum, and therefore this is a convenient time to settle by direct observation the question whether such motion exists.

## *Selenographical Notes.*

Apollonius and Firmicus.—Although both these objects, owing to their propinquity to the western limb, are foreshortened into somewhat elongated ellipses, and the satisfactory observation of the neighbouring region rendered difficult for the same reason, the observer will find much that is worthy of his attention and many details that apparently have not been recorded. Commencing with Alhazen on the north, bordering the western and south-western shore of the Mare Crisium, we have a nearly lineal chain of five fine regular ring-plains, closely associated with the highlands fringing this "sea," extending in a S.S.E. direction, nearly up to the north-west border of the Mare Fœcunditatis. Of these formations, Firmicus and Apollonius are the most southerly, if we except a sixth unnamed enclosure of a very irregular type abutting on the edge of the Mare. Apollonius, which, according to Neison, is about 30 miles in diameter, is characterized by a fine regular rampart, prominently terraced on the west and broken in the same quarter by two large contiguous craters, the more southerly being the larger. In spite of the foreshortening, it is easy to see, when libration is favourable, that the wall, especially on the east, is polygonal, approximating to the hexagonal class. Schmidt shows a low mountain on the southern side of the dark interior, and a small crater at the foot of inner slope of the north-east border. I have searched in vai the former, but have frequently seen the latter, which is far being a difficult feature. In the rugged region on the east are large conspicuous craters connected by what appears to me to deep coarse linear valley, though Schmidt draws two smaller cr on the site. Dr. Weinek's heliogravure from the Lick Observa negative, 1888 August 23, shows the neighbourhood under advanced stage of evening illumination to determine this p There are also two small but prominent craters at the foot o north-eastern *glacis*, which, though shown by Neison, appea have been overlooked by Schmidt. On the west of an imagi line connecting Apollonius and Firmicus, is a row of three ra conspicuous craters, of which Neison does not show a trace which Schmidt (if certain crateriform objects drawn on his are intended to represent them) misplaces. The rill-like v connecting the north-western flank of Apollonius with the sout side of its companion Firmicus is very noteworthy, though evident enough that it is not a true cleft. The region abound features of this type to a greater extent perhaps than any o on the visible surface. Firmicus, a larger enclosure with a s what lower and still more regular barrier, only broken conspicuous crater on the north, has a floor quite devoid of d except the spur, mentioned by Neison and shown by Schn which projects on its surface from the north-east wall. S years ago (1881 and 1883) Miss Ashley, of Bath, observing micus with a power of 130 on a 4-in. Wray-achromatic, dete a cleft cutting through the east and west walls and traversing southern end of the floor. She noted that when it was first 1881 Sept. 9ᵈ 11ʰ 30ᵐ, it was not very distinct, but became so as the evening advanced. It appeared to extend a distance beyond the limits of the formation at both ends, ar terminate abruptly. I have searched for this object (which i recorded in any maps or, so far as I know, mentioned elsew on several occasions, and have observed it twice (in 1884) evening illumination, when the terminator traversed the west of Hansen. There is little doubt that it is a cleft, though i not seen by me so satisfactorily as it appears to have been, ju from a drawing of it, which I have in my possession, by it coverer. I have not noted it since. In the country ea Firmicus are two rows of three prominent craters nearly pa and a solitary crater beyond, not one of which figures on Schn chart, and only the most northerly of the group nearest Fir on that of Neison.

T. Gwyn Elg

Beaumont House, Shakespeare Road,
Bedford, 1895, May 19.

## CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

### *Meteoric Radiants near γ Pegasi.*

Gentlemen,—

In connection with Dr. Doberck's letter ('Observatory,' May 1895, p. 199) on "Heis's T Radiants" near γ Pegasi, Sept. 15 to Dec. 20, and on his own observation of a rich shower on Oct. 7, 1891, at 0° +6°, I may note that I have frequently seen radiants in this region from the middle of July to the end of September. Meteors have also been seen from the same point in October and still later in the year, but in the autumnal months I have invariably watched a part of the sky far to the east of Pegasus, and a radiant in the latter place would easily escape detection. How many distinct showers are implicated in forming Heis's radiants it is impossible to say; but the wide differences in some of the positions show that several streams are probably involved.

I have always seen this radiant near γ Pegasi at about 6° +11° and 5° S.E. of the star. I give ten of my positions below, observed between July 12 and September 22, and the remarkable agreement between them will be apparent at a glance; in fact, allowing for small errors of observation, the radiants may be considered as practically identical. Side by side with the radiants I have placed their elements, computed by the late Dr. J. Kleiber, and included in his work 'On the Determination of Orbits of Meteor-streams.'

| D No. | Epoch of shower. | Max. date. | Radiant observed. | | π. | ☊. | i. | q. |
|---|---|---|---|---|---|---|---|---|
| | | | α. | δ. | | | | |
| | | | ° | ° | ° | ° | ° | |
| 210 | 1885 July 12–13...... | July 13 | 6 | +11 | 331·4 | 111·7 | 166·0 | 0·900 |
| 293 | 1885 July 27–Aug. 1 | July 31 | 5 | +10 | 47·5 | 128·4 | 162·6 | 0·427 |
| 294 | 1878 July 31–Aug. 1 | July 31 | 7 | +11 | 41·1 | 128·6 | 163·2 | 0·485 |
| 318 | 1886 Aug. 2–10 ...... | Aug. 4 | 7 | +11 | 57·9 | 132·5 | 161·2 | 0·372 |
| 412 | 1885 Aug. 17–20 ... | Aug. 20 | 5 | +12 | 120·2 | 148·0 | 126·1 | 0·058 |
| 456 | 1887 Aug. 21–24 ... | Aug. 24 | 5 | +12 | 129·2 | 151·4 | 106·8 | 0·037 |
| 465 | 1884 Aug. 23–25 ... | Aug. 25 | 5 | +10 | 135·9 | 153·1 | 87·4 | 0·023 |
| 529 | 1885 Sept. 12–15 ... | Sept. 15 | 5 | +11½ | 116·4 | 173·2 | 16·9 | 0·158 |
| 561 | 1887 Sept. 13–22 ... | Sept. 19 | 5 | +10 | 110·9 | 176·7 | 12·2 | 0·296 |
| 574 | 1884 Sept. 22 ......... | Sept. 22 | 7 | +10 | 111·2 | 180·3 | 9·4 | 0·322 |

The great dissimilarity in some of the orbit-elements will be noticed. submit, however, that the clustering together of apparent adiants (as exemplified in these γ Pegasids) during several months ossesses a *significant meaning* which has not yet been satisfactorily xplained.

The apparent radiants are of course different from the real when aberration is allowed for, and the true direction of the July Pegasids appears to be so inconsistent with that of the September Pegasids that it is difficult to suppose these showers can be physically associated. This, however, is on the assumption that the various meteoric orbits are parabolic, which is not an absolutely certain premise. But fully granting that the real directions of these Pegasids change rapidly with the time, the remarkable circumstance still remains that the *apparent motions are coincident*, and it is this peculiarity that observers would like to see accounted for.

The shower mentioned is only one amongst many of similar character, and it might be well to thoroughly investigate it from a theoretical standpoint to see if any results of planetary perturbation, of thickness of a stream, or other peculiarity of arrangement, can operate to bring about the sustenance of a fixed radiant. I would only add in connection with these July–Aug.–Sept. Pegasids as follows:—

1. The radiants may be depended upon to within 1½° of probable error.
2. They were determined from an average of 8 meteors each.
3. The meteors are swift and generally leave streaks before the middle of August, but move slowly afterwards, and are often trained in September.
4. The maximum periods of the shower, as observed, are July 27 – Aug. 4, Aug. 20–25, and Sept. 15–22.
5. There are other radiants near, viz. at 3° −2°, 13° +6°, 345° +15°, and 356° +25°, and the three first of these appear to have an extended duration.

Yours faithfully,
W. F. Denning.

Bristol, 1895, May 9.

## *Stellar Chromatics.*

Gentlemen,—

Permit a few remarks on the above interesting subject. After some experience as Director of the Colour-Star Section of the Liverpool Astronomical Society some years since, I fully concur with the remark of Capt. Wm. Noble that personal equation is a considerable factor in individual determination of tint, but I think that the idiosyncrasy is largely eliminated by the mean of several observers and a sufficient number of observations, so that the final deductions are fairly reliable. The above conditions being rigidly maintained, we concluded that results were as nearly within the range of an exact science as the nature of the subject permitted. After a reasonable trial we came to the conclusion that Mr. Franks' system of observation and notation was scientifically based, and sufficiently comprehensive for adoption; and as time passed we confess to increasing partiality for this method of work; hence, like Miss Brown, we regretted its non-adoption by Mr. Chambers, but we never thought it indispensable; and as the present Director of the Colour-Star Section of the British Astronomical Association is an observer of widest experience and skill, I, as a member of the Section, adopted his instructions, believing that possibly a change of mode might be attended with many advantages, especially as the subject admitted of a variety of methods of treatment. "Continuity," to use Miss Brown's happy expression, is undoubtedly an advantage; but in an eminently progressive science change is an equal advantage; and as Mr. Chambers very properly contemplates revision of his most useful 'Red Star Catalogue,' a change of mode is perfectly legitimate. In any case a competent Director will scarcely allow an *ab extra* direction, for all qualified men, while thankful for advice, will evince a strong personality in their search for truth. My chief regret is that my numerous engagements have prevented me being more than a nominal contributor to the sectional work. Permit me to add that I have a conviction, after prolonged observation, that slight *changes* of tint are characteristic of some coloured stars; possibly these changes are periodical, but data is not yet sufficient to determine. A useful work for combined observers would be to watch these changes, and carefully tabulated observations may reveal periodicity, which might prove a correlative to some of the phenomena of spectroscopic variables. $\alpha$ Ursa Majoris and *o* Ceti, both known as changeable in tint, might prove suitable subjects for observation. Mr. Chambers and Mr. Franks would be best qualified to furnish a list of suspects.

Yours faithfully,

Dorset, 1895, May 7. W. R. WAUGH.

## *The Constitution of Saturn's Rings.*

GENTLEMEN,—

At the present time it may be of interest to recur to the early speculations respecting the nature of the appendage to Saturn since its ring-like form was proved by Huygens.

We are told that Personier of Roberval, who succeeded Morin as Professor of Mathematics at the Royal College of France, was the first to suggest that it consisted of an immense number of minute satellites. Montucla says ('Histoire des Mathématiques,' vol. iv. p. 19) that he "conjecturoit que l'anneau n'étoit qu'un amas de satellites qui faisoient leur révolution autour de la planète principale, et qui étoient si voisins les uns des autres, qu'on ne pouvoit appercevoir leur intervalle d'aussi loin qu'est notre globe." But he gives no reference, and I have not been able to find this in ny of Personier's published papers. It will be noticed, however, hat the language of Cassini II., in a paper read before the French cademy on the 4th of May, 1715 ('Mémoires de Mathématique de Physique' for that year, p. 47), agrees almost verbally with e above, and does not speak of the theory in question as

originally suggested by himself. "Cette apparence," he says, "qui n'a point sa pareille dans les Corps célestes, a donné lieu de conjecturer que ce pouvoit être un amas de Satellites qui étoient dans le plan des autres et faisoient leur révolution autour de cette Planète, que leur grandeur est si petite qu'on ne peut pas les appercevoir chacun séparément, mais qu'ils sont en même temps si près l'un de l'autre qu'on ne peut point distinguer les intervalles qui sont entr'eux, ensorte qu'ils paroissent former un corps continu." A very unnecessary difficulty here occurred to Cassini. If these minute satellites moved round Saturn in accordance with Kepler's third law, their unequal velocities of motion and durations of revolution would produce accumulations in certain regions, causing variations of luminosity and irregularities of figure. This difficulty, he thought, might be explained by supposing that the whole mass of satellites was included within the atmosphere of Saturn and carried by it with uniform motion. The difficulty and its explanation both seem needless; but 180 years were to elapse before methods of observation undreamt of by Cassini gave evidence that these satellites do really revolve with different velocities. If these be regular, no irregularity of figure in the general appearance of the ring would be produced.

It is unnecessary to quote again Thomas Wright's acceptance of the satellite theory, as expressed in his 'Original Theory or New Hypothesis of the Universe,' published in 1750.

Yours faithfully,

Blackheath, 1895, May 3. W. T. LYNN.

## OBSERVATORIES.

ANNUAL REPORT OF THE PARIS OBSERVATORY.—M. Tisserand's report for the year 1894 shows continued activity during this period in all departments of the Observatory in spite of the exceptionally bad meteorological conditions, the sky being entirely overcast on 170 nights, and only on 94 nights could 4 hours continuous work be done.

The Observatory has been menaced in two directions: first from "Le chemin de fer de Sceaux," and, secondly, by the Municipal Council, who were about to widen la rue Cassini. The ill-effects from both sources have been reduced to a minimum, by due precautions in the first instance and a modification of plans in the second.

*Meridian Work.*—In 1882 Admiral Mouchez decided to issue a catalogue of all stars observed at Paris during the period 1837–1881. As this would embrace some 32,000 stars, the work was to be issued in eight volumes, four giving the places as observed, and four the catalogue proper. Two volumes appeared in 1887, another two in 1891, by the end of 1895 the third pair will be published, and it is hoped the whole will be completed in 1899. About 30,000 of these stars are from Lalande's Catalogue, but there remain some 10,000 stars of Lalande which were not observed up to 1881, and besides 4000 stars of the Catalogue have been insufficiently observed. These, which are now being observed, will be included in a supplementary catalogue, and it is hoped that this will be issued before the end of the century.

During 1894 over 18,000 observations were made with the circles, and considerable effort has been directed to finding the latitude of the Observatory. The Gambey circle has been devoted almost entirely to this work, by the method of measuring the distance between the nadir and Polaris as seen by reflexion. The reason given for the adoption of this method is that the error arising from flexure and imperfect values of micrometer-screws is thus reduced to a minimum.

To find the latitude from such measured distances, it is necessary to know the declination of Polaris. Assuming provisionally that the place given in the 'Connaissance de Temps' requires a correction −0″·1:

49 obs. of Polaris above pole give the secs. of latitude 10″·81
47 „ below „ „ 10 ·65

The mean of this gives a value, 10″·73, free from the error of the assumed place of the star, but affected with flexure. Direct observations of Polaris and the nadir in the years 1891–3 gave as seconds of latitude 12″·16. It is assumed that the difference of these two results is due to flexure, and a correction +0″·72 cos *z* has been deduced, which, applied to the value 10″·73, gives as the latitude of the Gambey circle 48° 50′ 10″·9.

Similar observations have been made with the great meridian circle, the instrument used for making the observations for the catalogue, with this result:

26 direct observations of Polaris below pole give the seconds of latitude 10″·61.

16 observations below pole by reflexion corrected for position of the mercury-trough give 11″·29.

It will be noted that the mean of the above results, 10″·95, though free from flexure effect, depends essentially, as a determination of latitude, on the adopted declination of Polaris. It is finally assumed that the correction to be applied to the place of the 'Connaissance' should be −0″·15, a value which is deduced from the Gambey-circle observations. Applying this the resulting seconds of the latitude become 11″·1.

Finally, the mean of the values found from the great circle and the Gambey instrument since 1887 is chosen as the latitude of the Observatory, and thus 48° 50′ 10″·9 is to be adopted in the revision of the catalogue of fundamental stars.

Bad observing weather prevented a large number of observations of Polaris above pole with the great circle. Ten observations in

April and May, and ten in November and December, give $-0''.36$ as the correction to the declination of the ephemeris, and $11''.3$ as the seconds of latitude, which appears not to have been used.

*Equatorial Work.*—The large equatorial coudé was entirely employed in photographic researches, and, in particular, in obtaining the splendid lunar photographs which are now well known.

The small coudé was used for observations of small planets and comets.

The "équatorial de la tour de l'ouest" was worked by MM. Bigourdan and Fayet, and besides observations of small planets and nebulæ, the following objects were observed: Comet Brooks (3 evenings); Comet Denning (14 evenings); Comet Gale (1 evening); Comet Swift (3 evenings); 300 measures of double stars, the diameters of Venus, Mars, Vesta, Saturn, Saturn's Rings, Jupiter and his satellites, and various phenomena.

With the east equatorial observations of small planets and comets had been made by M. Callandreau.

As to the progress of the work on the Astrographic Chart, 278 Catalogue plates have been taken during the year and 9 plates for the Ecliptic Chart—the comparatively small number of the latter being due to the cloudy skies before mentioned, and to the difficulty experienced in getting sufficiently sensitive plates. Much progress has been made with the measurement. Five ladies, having the use of two measuring instruments, have measured 120 plates of the zones +23° and +24°, which comprises the measurement of about 33,000 stars. The system of measurement at Paris differs from that at Greenwich in this particular, that in the Paris instruments a screw is used to measure the distance of stars from the lines of the réseau, whereas at Greenwich this is effected by a glass scale.

The reduction of these measures has been begun by the method formulated by M. Prosper Henry, and eleven plates containing 1760 stars have been reduced in this way.

The remainder of the report relates to the time system, meteorological work, and spectroscopic astronomy, the latter under the [illegible] able superintendence of M. Deslandres, at whose suggestion the [illegible] photographic registers of terrestrial magnetism have been re[illegible] undertaken, for comparison with solar observations. There is also given a list of papers published during the year by individual members of the staff, which contributes to show the scientific activity existing in the National Observatory.

---

The modest reports (leaflets) which Mr. Seabroke issues of [illegible] the work done at the Temple Observatory, Rugby, are apt to be overlooked as referring only to the educational side of his labours. Our Tuesday evenings are devoted to a special class of students, [illegible] and the other evenings to any members of the School who may care to attend. The average attendance is 3 or 4. The valuable series of double-star observations by which the Observatory is [illegible] best known to the outside world seems to be kept up, for we learn that a new Catalogue of measures is presently to be issued.

From the Report of Prof. Rümker we learn that the weather in 1894 was more favourable for observation at the Hamburg Observatory, and that a number of observations of small planets and comets were obtained. A series of observations of variable stars of long period was also undertaken. The testing of chronometers and the distribution of time-signals was carried on as in previous years.

## PUBLICATIONS.

Mr. Elger's Work on the Moon*.—The author's eminence as a selenographer has raised high expectations with regard to the complete map and description of the surface of the Moon which it was known that he was preparing for publication; and these expectations will assuredly not be disappointed. Mr. Elger's renown amongst selenographers is probably second to that of no one in the world, whilst no reader of the 'Observatory' requires to be reminded with what assiduity he has devoted himself to the detailed study of the most interesting formations on the visible hemisphere of our satellite. The book before us and the accompanying map are chiefly intended for the use of observers, but will doubtless be acceptable to an increasing number of those who, though they cannot be so described, take a general interest in the science and especially in the study of our nearest neighbour among the heavenly bodies. The map, as contained in the book, is given in four quadrants, each occupying an opening, or practically two pages; but it can also be obtained separately as a whole, either on a sheet or mounted on strong millboard and varnished. The scale is eighteen inches to the Moon's diameter; and on this scale the map is a model of clearness and distinctness, the author remarking that more detail might have been inserted, but he was anxious not to risk detracting from its value for reference, especially in the actual work of the observatory. The positions of the various objects depicted are principally based upon the chart of Beer and Mädler (in its last edition), and the larger and more recent map of Schmidt; but the shape and detail of most of the formations are derived mainly from the author's own drawings (which have been made from time to time during a period now amounting to thirty years), and a large number of photographs have been consulted and compared with these. Use has also been made of other excellent sketches and sources of information, particularly the descriptions in the late Prebendary Webb's 'Celestial Objects for Common Telescopes,' in which, as is well known, very special attention was given to selenography. All the more prominent and important features are here described, as well as some interesting details too minute to be marked on the map. The measurements (given in round numbers) are derived in most instances from Mr. Neison's (Nevill's) great work on the Moon published in 1876, though occasionally those in the introduction to Schmidt's elaborate chart are adopted.

---

* 'The Moon: a Full Description and Map of its Principal Physical Features.' By Thomas Gwyn Elger, F.R.A.S. (George Philip & Son.) 5s.

Mr. Elger's Introduction is somewhat lengthy, but will probably be considered by those who cannot actually take part in astronomical observing as the most interesting portion of the work. It commences with a rapid historical sketch of the progress of selenography and then discusses the different classes of the observed formations in order. Some of the ancient philosophers were sufficiently sagacious to conjecture that the light and dark portions of the Moon's surface owe their appearance to the inequalities of level; and Plutarch in particular expressed this view with great definiteness in the essay on the Forms in the Disc of the Moon, which forms one of his so-called 'Ethica' or Morals. Conjecture, however, did not become certainty until the telescope was applied to our satellite; so that selenography really began when the "Tuscan artist" Galileo obtained the first telescopic view of the Moon in 1609; to which there is a reference familiar to all in 'Paradise Lost,' Milton having paid a visit to the aged and blind astronomer at Arcetri, during his tour in Italy just before the outbreak of the English civil war. Galileo clearly recognized that the light portions of the lunar surface are in fact great elevations which catch the advancing and receding sunlight, whilst the dusky portions are tracts at a lower level; or, as Kepler expressed it, "Do maculas esse Maria, do lucidas esse terras." With regard to the former, the so-called maria or "seas," Mr. Elger remarks that this is "a convenient name which is still maintained without implying that these areas, as we now see them, are, or ever were, covered with water. Some, however, regard them as old sea-beds, from which every trace of fluid, owing to some unknown cause, has vanished, and that the folds and wrinkles, the ridges, swellings, and other peculiarities of structure observed upon them, represent some of the results of alluvial action. It is of course possible, and even probable, that at a remote epoch in the evolution of our satellite these lower regions were occupied by water; but that their surface, as it now appears, is actually this old sea-bottom, seems to be less likely than that it represents the consolidated crust of some semi-fluid or viscous material (possibly of a basaltic type) which has welled forth from orifices or rents communicating with the interior, and overspread and partially filled up these immense hollows, more or less overwhelming and destroying many formations which stood upon them before this catastrophe took place."

These dusky areas, then, on the Moon have retained the name of Maria, just as many other things are still called by designations known no longer to be appropriate. Twenty-three of them have received distinctive names, seventeen of which are wholly or in great part confined to the northern hemisphere and to the south-eastern quarter of the southern; the south-western quadrant being to a great extent devoid of them. The largest of all is the so-called Mare Procellarum, which, with its bays and inflections, covers an area, according to Schmidt, of nearly two millions of square miles; it extends from a high northern latitude to beyond latitude 10° in the south-eastern quadrant. Next comes the Mare Nubium, principally located in the south-eastern quadrant, and then the Mare Imbrium, wholly confined to the north-eastern quadrant, and covering an area of about 340,000 square miles.

We have not space even to refer to Mr. Elger's remarks on the walled plains, mountain-rings, ring-plains, craters, &c., objects which, in their almost endless variety and bewildering number, give, more than other formations, that marvellous appearance to the telescopic aspect of the Moon which, since the days of Galileo, have never failed to excite the astonishment of the beholder. But we must devote a few words to what he says about the comparatively newly discovered formations now known under the name clefts or rills, it being understood that this last word is intended to represent the German "Rillen," *i. e.* grooves or furrows, which is, indeed, its original sense in Celtic (as in the Welsh "rhill"), from which our corresponding word is derived, though now used with the slightly altered meaning streamlet, because terrestrial rills usually contain water. The first to detect these curious objects on the Moon was Schröter, who noticed eleven between 1787 and 1801, the defining power of his telescopes enabling him to see only those which are the most prominent, but later discoveries have since raised the number to nearly a thousand. Schmidt wrote a special monograph, 'Ueber Rillen auf dem Monde,' and estimated the breadth of those observed by him at from a quarter of a mile to two and a quarter miles. Webb says of them: "These most singular furrows pass chiefly through levels, intersect craters (proving a more recent date), reappear beyond obstructing mountains, as though carried through by a tunnel, and commence and terminate with little reference to any conspicuous feature of the neighbourhood." The following portion of Mr. Elger's remarks in reference to them will be read with interest. After mentioning the old exploded notion that they are artificial constructions, and the theory of the imaginative Gruithuisen that some of them represent roads cut through immense forests, he says:—

"From the position of some rills with respect to the contour of the surrounding country, it is evident that if water were now present on the Moon, they, being situated at the lowest level, would form natural channels for its reception; but the exceptions to this arrangement are so numerous and obvious that the idea may be at once dismissed that there is any analogy between them and our rivers . . . . Some selenographers consider them to consist of long-extending rows of confluent craters, too minute to be separately distinguished, and to be thus due to some kind of volcanic action. This is undoubtedly true in many instances, for almost every lunar region affords examples of crater-rows merging by almost imperceptible gradations into cleft-like features, and crater-rows of considerable size resemble clefts under low powers. Still it seems probable that the greater number of these features are immense furrows or cracks in the surface and nothing more; for the higher the magnifying power employed in their examination, the less reason there is to object to this description."

The great problem now before selenographers is to obtain, if possible, some decisive evidence of changes in progress on the
lunar surface. It cannot be said that much has yet been obtained.
The difficulty arises from the differences presented by the appear
ance of a lunar object as seen under different illuminations.
Those of us whose memories go back thirty years remember th
stir caused by Schmidt's announcement that the little crater Linn
in the Mare Serenitatis had disappeared, being filled up, as w
supposed, by an igneous outflow. Something stills exists the
but it is a much shallower and less conspicuous object than it w
if all the older representations and descriptions can be relied
Differences of illumination will not explain the change, which
real, is probably of the nature of the falling of the walls of
crater into the interior and filling this in great part with
*débris*. Should other changes of a similar kind be noticed it
greatly strengthen the possibility of an actual change having occur
in Linné. Some years afterwards (in 1877) Dr. Klein called att
tion to a change he thought he had noticed in the neighbourh
of the crater Hyginus; but this, too, is a matter subject to do
and it may only amount to the recognition of a feature previo
unnoticed. Mr. Elger points out that we are very far ind
from being in a position to prove a negative; and that, "notw
standing the multiplication of monographs and photographs,
knowledge we possess, even of the larger and more promin
objects, is far too slight to justify us in maintaining that chan
which on earth we should use a strong adjective to describe, h
not taken place in connection with some of them in recent yea
Selenography, then, with our improved instruments and meth
of research, has probably a great future yet before it. "A c
plete photographic survey of a few selected regions, as a basis
an equally thorough and exhaustive scrutiny by direct observat
would, it is believed, lead to a much more satisfactory and hop
method for ultimately furnishing irrefragable testimony as
permanency or change than any that has yet been undertaken."

Thus Mr. Elger closes his Introduction. Into the details of
body of the work we cannot enter. To the astronomer,
especially to the selenographer, we may say emphatically o
what Osiander said of that of Copernicus: "eme, lege, fruer
whilst we may remind the non-scientific reader who t

n interest in the study of the results of astronomical research, hat attention bestowed upon the heavenly body which, being so nuch nearer, can be much more advantageously studied than any ther, cannot fail (though all science teaches patience) to be productive of interest and ultimately of benefit.

It should be added that some tabular information, very useful to the observer, is given in the Appendix. This consists of lists of the Maria, of the most prominent mountain-ranges and remarkable hills, and of the principal ring-systems, light-surrounded craters and light-spots, all separately arranged under the quadrants in which they are contained. Also tables (useful in comparing drawings) from which the position of the lunar terminator may be readily found for midnight of any day between the years 1780 and 1900; a list of numerical details of the Moon's magnitude &c., and of the elements of her orbit; and an alphabetical index of all the formations described in the body of the work.

---

Solar Energy [*].—Speaking generally, this book is an attempt to explain the reason of certain facts, *e. g.*, the varying rotation period of sun-spots, the connection between sun-spots and earth magnetism, variable stars, and other things, the causes of which are at present unknown to most persons. It may perhaps be unnecessary to say that we think the author has not made out his case, and our readers may not be surprised to hear that it is electricity, the *deus ex machina* so dear to theorists, which causes these things. The keystone of the theory appears to be given by this passage: "It is an absolute certainty that electrical currents of enormous quantity and potential are constantly passing between the Earth and the Sun." No doubt with this hint each of our eaders will be able to supply the rest of the explanations for imself. We will just give another hint or two for his guidance. ur author appears to think, first, that the planets also give out lectric currents which impinge on the Sun and somehow cause n-spots and influence their motion: also that the phenomena of mets are analogous to an experiment with the elementary ectrophorus (we are surprised that no one thought of this efore!) and that the variability of Algol is due to the existence of dark planet which develops electricity. By the foregoing emarks we do not mean to imply that the book is wholly incor-ect; from it a reader may learn many astronomical facts, for ere are frequent extracts from the writings of Huggins, Ball, d Proctor (who is persistently called "Professor"), and we uld not deny that electricity may be a potent factor in solar d cosmical physics, but this is not so well established as the thor, who brings very little sound evidence to bear on the nt, would have his readers believe.

[*] 'The Source and Mode of Solar Energy throughout the Universe.' By . Heysinger, M.A., M.D. Lippincott Company, Philadelphia, 1895.

# NOTES.

THE MEMORIAL TO THE LATE PROFESSOR JOHN COUCH ADAMS.—It will be remembered that early in the year 1892, shortly after the death of Prof. Adams, a committee was formed to take steps for placing a memorial to the distinguished astronomer in Westminster Abbey. At a meeting held on 1892 February 20 in St. John's College, Cambridge, under the presidency of the Master, Dr. Taylor, it was resolved that, if circumstances permitted, a memorial should be placed in Westminster Abbey, and that the memorial should consist of a bust, with tablet and inscription. Other resolutions were also carried treating of the disposal of any surplus money after paying the expenses necessary for carrying out the first two resolutions. For certain reasons, however, the Dean of Westminster was unable to sanction any site for a bust in an appropriate part of the Abbey, but offered a position for a medallion; and at a meeting held on 1892 July 9 it was therefore resolved that the memorial consist of a medallion and inscription. This resolution has now been carried into effect, and the medallion, placed in its position in the nave, was unveiled on Thursday May 9 last by the Duke of Devonshire, Chancellor of the University of Cambridge. At 1.30 P.M. a distinguished company assembled in the Jerusalem Chamber, where Dean Bradley briefly explained the proposed procedure, and described the position of the medallion, near the memorials to Newton, Darwin, Joule, and others. The Duke of Devonshire mentioned the circumstances which had led up to the present occasion, and the Master of St. John's College, Cambridge, recounted them in greater detail. The latter remarked that some delay in the completion of the medallion (owing to the illness of the sculptor, Mr. Bruce-Joy) had brought us to an interesting date for the unveiling, namely the Jubilee Year of the theoretical discovery of Neptune; for the immortal note which Adams had handed in at the Royal Observatory, Greenwich, announcing the result of his calculations was dated 1845 October. Lord Kelvin referred to the other great discoveries of Adams. Prof. Stokes, representing Pembroke College, Cambridge, remarked that this College had also a share in Adams; for when, owing to his not taking orders, his fellowship at St. John's perforce lapsed, he, the speaker, "had thought it would be a nice thing to attach this great mathematician to their own College by offering him a fellowship," which Adams accepted and retained till his death. The Master of Pembroke College, Oxford (Prof. B. Price), ventured to claim for England generally, including Oxford, some share in the glory of Adams. It was at the Radcliffe Observatory, Oxford, that Leverrier and Adams had first met. Prof. Price insisted further on what had already been said by others concerning Leverrier, whose name must ever be linked with that of Adams. A most graceful and scholarly speech was next delivered by the Rt. Hon. L. H. Courtney, who, as a Cornishman, testified to the pride with which Adams' native county had heard of his wonderful discovery, and to the bond between Cornwall and St. John's College, Cambridge, of which Adams and himself were instances. After votes of thanks to the Chancellor and the Dean had been moved by the Members for the University of Cambridge, the company proceeded to the site of the memorial, where, after the recitation of a short collect by the Dean, the Chancellor unveiled the Medallion, representing a head of Adams, with the inscription

JOHN COUCH ADAMS
PLANETAM NEPTUNUM CALCULO MONSTRAVIT MDCCCXLV.

It was difficult to see the inscription, and there were those who did not think the likeness very good; but the medallion is certainly a beautiful work of art.

---

OBITUARY.—By the death of M. L. Trouvelot, of Meudon Observatory, the science of observational astronomy has lost a keen and accurate worker. M. Trouvelot was born at Guyencourt, France, in 1827. The events of his early life, which was spent in his native country, do not connect themselves with astronomy; but in 1857 he emigrated to America, where for some years he seems to have devoted himself to the pursuit of Natural History, and between the years 1868 and 1876 contributed several papers relating to insects and kindred subjects to the Boston Natural History Society. As an astronomer his first subject of observation was the Sun, and in 1875 he published his observations of so-called "veiled spots," which, unlike the other sun-spots, he saw in all latitudes, even within 10° of the solar pole. In 1876 he began his systematic observations of the planets, the subject with which his name is particularly associated, and in 1881 presented to the American Academy of Sciences a valuable paper on Jupiter, giving the various lengths of the rotation period as determined from different spots seen on the surface of the planet; but the work done in America, which chiefly rendered his name famous, is the magnificent series of drawings of Jupiter, Saturn, Solar phenomena, the Andromeda nebula, and other astronomical objects published at the expense of the Bache fund in Vol. viii. of the 'Annals of Harvard College Observatory.' In 1882 he left the United States and joined M. Janssen at Meudon Observatory, where he devoted his energies chiefly to solar observation. Some remarkable observations of prominences made by him are recorded. On 1885 June 26 he observed two immense prominences, their height being estimated at 300,000 miles, at either end of a solar diameter, and, again, on August 16 of the same year, he saw one almost as large, with a spot at the opposite end of the diameter on which the prominence was situated. More recently, in June 1891, he saw a prominence suddenly detached from the limb, a phenomenon which he compares to the well-known Carrington-Hodgson observation. M. Trouvelot was a frequent contributor to the 'Comptes Rendus,' the 'Revue d'Astronomie,' and also to this Magazine. His last publication of importance was a memoir on the planets Venus and Mercury, communicated to the Société Astronomique de France in 1892,—the result of many years' work, and important as giving a value of the rotation period of Venus differing from previously accepted values. Speaking of inferior planets recalls the fact that the deceased astronomer accompanied M. Janssen to the Caroline Islands to observe the Total Solar Eclipse of 1883, where he and Prof. Palisa undertook a search, which, it is needless to say, was fruitless, for an intra-Mercurial planet. M. Trouvelot died at Meudon on April 22 last.

---

The parallax of $\eta$ Cassiopeiæ forms the subject of No. 6 of the 'Contributions from the Observatory of Columbia College, New York.' It will be remembered that the series contains Prof. Jacoby's parallaxes of $\mu$ and $\theta$ Cassiopoiæ as deduced from the Rutherfurd photographs, and in the present instance the series of 27 negatives taken between 1870 July 30 and 1873 Dec. 21 of the stars in the neighbourhood of $\eta$ Cassiopeiæ by Prof. Rutherfurd have been reduced on the same principles by Mr. Herman S. Davis. It is difficult to get suitable comparison stars, and so Mr. Davis has had to reduce a larger number than usual, which has added t the labour; but we confess to being glad this was so, as the resul is so much increased in value. In fact, Mr. Davis himself, furthe on, seems to think so, for he remarks :—"Considering the dif culties which beset the investigation of the parallax of this st and the probability that all previous determinations have be made with a single comparison star, which may itself hav parallax, it would seem that the result here given is not imposs large." The parallax deduced from three pairs is

$$\pi = +0''{\cdot}443 \pm 0''{\cdot}043,$$

and from all six pairs

$$\pi = +0''{\cdot}465 \pm 0''{\cdot}044.$$

Mr. Davis prefers the first value, because it is not at all impos from the equations that one or other of the stars in the l pairs has a parallax of its own. The result is larger than prev determinations, and is, we think, entitled to some weight, sidering the individual conditions. The determinations are :—

| | |
|---|---|
| O. Struve................ | +0″·154 |
| Schweizer and Socoloff .... | +0 ·275 |
| Davis .................. | +0 ·443 |

---

Mr. Lowell's Lectures on Mars.—Those who were at the last meeting of the Royal Astronomical Society had an opportunity of seeing, possibly with a feeling of scepticism, some wonderful pictures intended to represent the planet Mars as observed at the Lowell Observatory in Arizona. Mr. Lowell has been lecturing on Mars to crowded audiences, and a newspaper report of his lecture is reproduced in the 'Publications of the Astronomical Society of the Pacific,' No. 41. We prefer not to give this report *in extenso* here, but it states Mr. Lowell's "firm conviction that intelligent beings occupy Mars, who have contrived public works of vastly larger extent than we on the Earth have dreamed of"; that Mr. Lowell went on to show that "the men might be 19 feet high and the women 16 or 17 feet," and so on. The following footnote, added by Prof. E. S. Holden, especially its last sentence, seems to us to be a reasonable criticism on the lectures:—

"The foregoing report may apparently be taken as a semi-official account of the conclusions reached by Mr. Lowell from his observations of 1894. Before accepting as proved 'the marvels of irrigation and vegetation which we see on the planet Mars of to-day &c.,' it would seem that observations ought to be continued for more than a single season, so as to make it certain that these are in fact marvels of vegetation which are seen. Something is seen, no doubt; but I may say that nothing has been observed at the Lick Observatory during the years 1888–1895, so far as I know, which goes to confirm the very positive and striking conclusions here described. It is a point to be noted that the conclusions reached by Mr. Lowell at the end of his work agree remarkably with the facts he set out to prove before his observatory was established at all."

---

Dr. See has deduced the elements of the orbit of $\kappa$ Pegasi from all available observations, and finds

| | | | |
|---|---|---|---|
| P ...... | 11·42 years. | $i$ ...... | 81°·2 |
| T ...... | 1896·03 | ☊ .... | 116·25 |
| $e$ ...... | 0·49 | $\lambda$ ...... | 89·2 |
| $a$ ...... | 0″·4216 | $u$ ...... | −31°·5236 |

The residuals are small, considering the extreme closeness of the components.

Dr. See remarks:—"Prof. Burnham has repeatedly called the attention of astronomers to the high importance of systematically following such extremely rapid binaries with large telescopes, so that we should in a few years get good orbits, which in the case of most binaries would require the observations of centuries." He further states that the minimum distance (0″·034) will occur just after 1896·03, and measures made on either side of the peristron will be very valuable, and suggests that observers should atch for it in the present summer and in the autumn of 1896.

The recent measures are:

| | | | |
|---|---|---|---|
| 1894·51 .... | 117°·6 | 0″·19 | Barnard. |
| 1894·83 .... | 114 ·8 | 0 ·14 | Lewis. |

---

Dante's Astronomy.—The Bishop of Salisbury is now on a oyage in the Southern hemisphere, and is communicating notes n his travels to a certain publication, to which we have had our ttention called as containing some interesting remarks by his ordship on Dante's knowledge of astronomy; he says:—

"Dante places the mount of purgation in the Southern hemi-here, which he supposes to be otherwise a tract of sea. On rst entering it on Easter Day, A.D. 1300, he sees early in the orning towards the South Pole four stars, which he says were ever seen except by the first men, *i. e.*, by Adam and Eve when n the terrestrial Paradise, which he places at the top of the Iount of Purgatory. He speaks of these stars as very brilliant, nd of the Northern hemisphere as suffering by being deprived of hem. Clearly then he had never seen them himself, but as learly he must have heard of them from others. There is, I hink, no reasonable doubt that they are the remarkable group lled the Southern Cross—the two principal stars of which (one eing of the first magnitude) are just about as far from the South ole as the pointers of the Great Bear are from the North Pole.

"How he knew of them no one has as yet ascertained; but hey were known to Ptolemy, I believe, and must have been seen y every early voyager who entered the tropics. I asked Captain arby how far north he had seen them, and he replied at the aedalus Reef, which is outside the tropics somewhere, as I said, n the latitude of the first cataract of the Nile. Hence many ravellers in Egypt and the Red Sea must have seen them, not to peak of Marco Polo, who went much longer voyages (1275–1296), ome years before Dante wrote. For the Southern Cross is as ften visible in these regions as the Great Bear, which cannot fail o strike everyone who watches the sky for a whole night in the orthern hemisphere.

"We were even more interested in identifying another group f stars mentioned by Dante in the Eighth Canto. He seems to onsider the four stars of the Cross as symbols of the four ardinal or, as we might say, natural virtues—those which all umanity recognizes, viz. Justice, Temperance, Fortitude, and rudence—and as such they shine on the face of Cato of Utica, he type of heathen virtue, and the wonder of the Mount of urgatory. They are seen by Dante in the morning before the wn, just as we see the Southern Cross now about 5 A.M. But the evening of the same day he sees in their place three brilliant lights, which are doubtless the symbols of the evangelical graces of Faith, Hope, and Charity—a beautiful parable of the progress of human life under the Gospel."

The Bishop then proceeds to identify these three stars seen in the evening as Canopus, Achernar, and Fomalhaut; and asks whether Dante's knowledge of these stars was correct as to their position on Easter Day (April 10), 1300.

---

THE proverbial fickleness of the English spring has been well exemplified in the course of the past month. A brilliant and nearly cloudless period marked the commencement of the month, the sunshine during the ten days May 2 to 11 amounting to 106·8 hours out of a total of 151 hours during which the Sun was above the horizon, or 70 per cent. of the possible duration. In the month of May 1893 a similar period of ten days (May 4 to 13) gave 106·6 hours, which is likewise 70 per cent. of the possible amount.

Great warmth prevailed from May 9 to 14, the mean maximum temperature for the 6 days being 76°·2, which is 13°·6 above the corresponding average value. The highest temperature occurred on May 12, and was 81°·3, a remarkable value for so early a date; but this was exceeded in 1868 on May 3, when 82°·3 was recorded, and in 1867, on May 6 and 7, when readings were recorded of 83°·3 and 83°·6 respectively. The night temperatures were also remarkably high for the season, and on the night of May 12–13 the temperature did not fall below 57°·3, and on the following night below 55°·5. These warm night temperatures at this early period have only once been exceeded in the 54 years 1841–1894, namely on 1867 May 7, when 57°·5 was recorded. The mean daily temperature for May 12–14 was 66°·0, being 13°·7 above the 50 years' average. Within three days a severe change to extremely cold weather occurred, the weather on the 17th presenting a complete contrast to that which had been experienced on the 12th, 13th, and 14th. The highest temperature for the day was 46°·8 only, as compared with 81°·3 on the 12th, and the lowest temperature was 39°·6, thus giving an extreme range of temperature of 41°·7 in less than a week. The mean temperature was 42°·9, which is 10°·4 below the average, and the difference between the means of temperature for the 13th and the 17th amounted to 24°·7. This is excessive; but similar changes are not infrequent in the spring and early summer months. Thus in 1891 the warm temperature of May 12, viz. 64°·4, or 12°·1 above the average, was succeeded by remarkably low values on the 16th, 17th, and 18th, which were below their average values by 11°·8, 12°·9, and 12°·8 respectively, and other instances could be adduced. Towards the end of the month the weather has again become warm, a temperature of 86°·2 in the shade having been recorded on the 30th.

---

**Société Belge d'Astronomie.**—We are informed that a society was established in Brussels under the above title in December last, having for its object the popularizing and the development of Astronomy and the kindred sciences, Geodesy, Meteorology, and Terrestrial Physics. The President of the Society is an amateur astronomer, M. F. Jacobs; the names of other officers familiar to us are M. P. Stroobant, who is one of the Secretaries, and MM. C. Lagrange and F. Terby, who are members of the Council. The Society asks the modest subscription of 6 francs per year from ordinary members, and a donation of 300 francs constitutes the giver a life member. We wish the Society every success.

---

The following expression of some novel views on the Univers Time movement is from the 'Allahabad Pioneer Mail':—

"There is a Church of England clergyman in Victoria w absolutely declines to recognize the standard time adopted Parliament. He rests upon Nature and the God of Nature, a rings his bell for service twenty minutes after other churches in full swing. The following was his preliminary address to congregation just before delivering his sermon on the first event Sunday morning:—'My brethren,—During the past week extraordinary attempt has been made by Parliament to alter time of day. I wish to announce that I intend to take no no myself of such alteration—nor will the Sun do so either. Sun will rise and set as heretofore regardless of the unauthor mandate of men in temporary authority. I do not know sufficient cause for such alteration, and I repeat that I shall ad to the only true time, and let those who are weak enough to ac this false Parliamentary time do so if they wish. The text this evening's sermon will be found in the nineteenth verse of hundred-and-fourth Psalm—'The sun knoweth his going down

---

The difference of longitude between Madras and Greenwi being determined telegraphically by officers of the Indian Trig metrical Survey. The route chosen is *viâ* Berlin and Teh and Capt. Burrard, R.E., and Capt. Lenox-Conyngham, R.E. now at Greenwich determining their difference of Personal E tion, before measuring the arc Greenwich – Berlin. These off have already completed arcs of the chain further east. We pose to give some more information on this subject in a subseq number.

---

We are glad to be able to congratulate Mr. Frank McClea his election as a Fellow of the Royal Society. Not only Mr. McClean himself done valuable work for astronomical sci by his solar spectroscopic researches—his photographic compari of the spectra of metals and of the Sun and his comparison of the visible spectra of the high and low Sun are well known,—but he has also been the instrument enabling others to do similar good work. The Isaac Newton studentship endowed by Mr. McClean has in several cases directed mathematical learning at Cambridge to Astronomy, and his late gift of instruments to the Cape Observatory will no doubt enrich the science from the observational side.

The American weekly journal 'Science' has been reorganized, and is now "conducted as a scientific journal for men of science." Prof. E. C. Pickering is interested in securing the adequate representation of astronomy in the journal, and asks for contributions, in the way of short notes, abstracts, or longer papers relating to the science.

The list of Birthday honours contained the name of Admiral W. J. L. Wharton, who has been created C.B. Admiral Wharton's connection with Nautical Astronomy is well known. We tender our sincere congratulations.

Erratum.—In the fourth line of the postscript to Prof. Geelmuyden's article on p. 193 of our last number, the word "above" was interpolated by error; the phrase should have implied "notation used in the 'Nautical Almanac.'"

We hear that the establishment of a new Colonial Observatory at Perth, the capital of Western Australia, is in contemplation.

---

## From an Oxford Note-Book.

In circulating some interesting particulars as to the Total Solar Eclipse of 1898 Jan. 21–22 (well visible in India with a duration of 1½ minutes and a solar altitude of 45°) the Superintendent of the 'Nautical Almanac' remarks that information as to the meteorological conditions prevailing at various points along the track of the eclipse is being collected. It is an obvious duty to collect such information with all due care; but one cannot but reflect how misleading it is apt to be when judged by the event. In the case of the ill-fated 1889 eclipse, the prognostications for South Africa were most favourable, almost amounting to certainty of fine weather; those of Cayenne nearly hopeless. The late lamented Father Perry nevertheless secured observations at Cayenne, though at the cost of his life; while the Sun was completely hidden for several days in South Africa.

---

A notice of Mr. Stanley Williams' investigation on the rotation of Saturn occurs elsewhere in this number (p. 221); but it can scarcely be superfluous to call attention to it here. He finds the mean rotation period to be decreasing as follows:—

| | | | | | |
|---|---|---|---|---|---|
| In 1891 it was | $10^h$ | $14^m$ | $21^s{\cdot}8$ | |
| | | | | diff. = $43^s{\cdot}6$ |
| „ 1892 „ | 10 | 13 | 38·2 | |
| | | | | diff. = 45·8 |
| „ 1893 „ | 10 | 12 | 52·4 | |
| | | | | diff. = 16·6 |
| „ 1894 „ | 10 | 12 | 35·8 | |

Allowing a considerable margin for accidental error, we must still admit that the great planet is undergoing a marvellous change under our very eyes, or, rather, under those of Mr. Stanley Williams. Further, the remarkable differences of rotation velocity in different longitudes seem to be established beyond question. Such work as this takes very high rank indeed, and adds a new name to the long roll of famous English amateur astronomers.

---

The question was put recently:—How can an equatorial intended for photographic work, without circles or micrometer, be adjusted? I think the simplest way is to turn it on the Pole and take a photograph with the clock driving. If it is not in adjustment, the stars will trail, and the direction of the trail will indicate the direction in which the instrumental pole deviates from the actual. If a simple continuous exposure be given, it will not be easy to determine in which of two opposite directions the stars have trailed. But if the exposure be interrupted in some arbitrary way (say expose for 10 min., close for 5 min., and then expose for 20 min.) the beginning of the trail can be distinguished from the end. The relation of the direction of the trail to the displacement of the polar axis is determined by the following consideration: The apparent motion of a star will result from the composition of two rotations—that of the earth about its axis, and that of the instrument about its axis. These axes are nearly but not quite coincident, or, rather, opposed. By the principle of composition of rotations the resulting motion is a rotation about an axis in their plane of intersection and bisecting the angle between them, *i. e.* nearly perpendicular to both; and is thus a motion nearly perpendicular to the plane containing the two axes. Thus if the pole of the instrument is too *low*, the stars will trail towards the east; if too *high* towards the west; if the instrumental pole is eastwards the trails will be to the *north*, and if westwards to the *south* (other investigators, please verify). For a combination of two errors, in altitude and azimuth, the trails will be oblique; but there should be no difficulty in analyzing the error into its components.

---

Much has lately been written and spoken of argon and helium, and very much more remains to be said: but no better instance of the "true word spoken in jest" need be looked for than the remark of Prof. Housman at the dinner given by University

College, London, to Prof. Ramsay, when he complimented the distinguished discoverer on having at last "run helium to earth."

---

The following paragraph, which I cut out from a weekly paper of a few days ago, is like a voice from the dead:—

"It is a startling fact that if the Earth were dependent upon the Sun alone for heat, it would not keep existence in animal and vegetable life upon its surface. It results from the researches of Pouillet that the stars furnish heat enough in the course of the year to melt a crust of ice seventy feet thick—almost as much as is supplied by the Sun. This may appear strange when we consider how immeasurably small must be the amount of heat received from any of these distant bodies. But the surprise vanishes when we remember that the whole firmament is so thickly sown with stars that in some places thousands are crowded together within a space no greater than that occupied by the full Moon. We learn from this fact that we are greatly indebted in the physical world to the cumulative operation of small and remote influences. The same truth holds good in the intellectual world."

I had the curiosity to turn up Pouillet's memoir, which is in the 'Comptes Rendus' for 1838—before Joule had made his wonderful investigations on the mechanical theory of heat. Pouillet had determined the amount of heat received from the Sun by three different methods, and found it insufficient to maintain observed temperatures on the Earth's surface. In the absence of any knowledge of internal energy, or sources of heat, therefore, the balance is set down to radiation from space, with the result correctly stated in the paragraph quoted. But how did the paragraph get into contemporary literature? Was it dragged from its grave merely to point the feeble little moral at the end?

---

IMPERIAL INSTITUTE.
NOW OPEN for the SUMMER SEASON, 1895.
Admission TO-DAY, ONE SHILLING.

IMPERIAL INSTITUTE.—UNITED KINGDOM SECTION.—EXHIBITION of PHOTOGRAPHY. Most interesting processes daily shown in operation. Open from 11 a.m. until 10 p.m. TO-DAY. EXHIBITION of RAILWAY APPLIANCES and INVENTIONS opens on JUNE 1. Machinery in Motion and Working Models.

So runs the advertisement in the daily papers. The exhibition of photography interested me for one or two reasons, and one of these last evenings I made the voyage to South Kensington and paid my shilling. It was not a bad investment, as things go; there was music (but no dancing) and gardens and illuminations and refreshments (extra), and, ultimately, the Exhibition of Photography, including contributions from the Royal Society, the Royal Astronomical Society, and the leading observatories and amateurs. The lighter entertainments were, by a thoughtful arrangement, conducted in a different part of the building from the more serious, so that they might be taken separately. I took the business first, and found the collection of astronomical photographs thoroughly interesting. The lighting arrangements are not well adapted for showing the positives, but there is nothing to complain of in the case of prints. If the exhibition is not all one hoped, it is still far from being unworthy of a visit.

---

According to a weekly contemporary, the author of a new book has consulted a Miss Horniman, an astrological adept, on the probable success of his book. "Jupiter trine Saturn shews great success, which will be well deserved, as the Greater Fortune (Jupiter) is in the author's House of Pisces and trine to Herschel, which will bring even greater popularity than is anticipated." I did not know that the astrologists had made room for Uranus in their system. It must have been a great concession, and not the least tribute to the glory of Herschel. Apparently, however, they have stopped there, and refused to adopt the modern name for the planet, so that I suppose Neptune is treated with scant respect. Or is his disturbing influence used as an excuse for the occasional failure of the horoscope?

---

A paragraph in the 'Daily Telegraph' recently drew attention to the fact that "Scripture is one of the strictest subjects of examination for admission to the Navy," illustrating this remark by the following letter from an intending candidate to his father who had learnt the fact at the last hour and written off to his boy in some alarm:—"Dear Dad.—Dont worry. Had heard about the Scriptures from a chum. Know all about them. Have been reading up the 'Burning Bush,' which is the favourite here. Am sure to pass." And I am sure I hope he did, though history sayeth not. The comment of the 'Daily Telegraph' is "that there is no accounting for the idiosyncrasies of examiners"; from which it may be gathered that the writer is not yet hardened enough in journalism to suggest any reference to Cassabianca. But if anyone feels equal to the task of accounting for the above idiosyncrasies, after the D.T. has given it up, perhaps he would also like to try and explain why candidates for assistantships in the Royal Observatory are not only examined in mathematics, astronomy, and languages, but asked to climb a rope under inspection! Not the rope of the Indian juggler whose north end is in the skies (*sic itur ad astra*), but a common rope such as candidates for the Navy have also to climb.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

No. 229. JULY. 1895.

## MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, June 14, 1895.

Dr. A. A. Common, F.R.S., *President*, in the Chair.

*Secretaries*: Prof. H. H. Turner, M.A., B.Sc., and
E. W. Maunder.

The Minutes of the previous Meeting were read and confirmed.

*Mr. Maunder.* The Society has received 83 presents since the date of the last Meeting. Of those calling for special notice I might mention two volumes of the publications of the Potsdam Astrophysical Observatory—the one containing observations of spectra of stars, and the other observations of sun-spots; a work by Mr. H. S. Davis giving the results of his investigation of the parallax of $\eta$ Cassiopeiæ from measures of the Rutherfurd photographs. We have also received a pamphlet from Dr. Bredichin, entitled "Mouvements des substances émises par les Comètes 1893 II. et 1893 IV.," and a paper by Prof. H. S. Pritchett on the Eclipses of Saturn's Satellites.

A vote of thanks was accorded to the donors of the presents.

*Mr. Knobel* in presenting his paper on "A Catalogue of Stars in the Calendarium of Mohammed Al Achsasi," said that he had lately obtained, from a bookseller's in London, a 17th Century Arabic MS. of this Calendarium. The author's name was not to be found in the usual sources of information about Oriental astronomers, and no copy of the MS. existed at the British Museum, the Bodleian, the Escurial, or the Leyden libraries; but he had found it in the Catalogue of the Khedive's library at Cairo, with evidence to show that the MS. was probably written at Cairo. The Calendarium contained a catalogue of stars, which he had translated. The positions of 112 stars were given in R.A. and Dec., the Right Ascensions being reckoned from the first point of Capricornus, as was usual in Arabian catalogues. The positions appeared to be for about the Epoch 1650. Mr. Knobel had carefully compared this catalogue of Al Achsasi with that of Al Tizini, translated by Hyde and published in his edition of Ulugh Beigh in 1665, and came to the conclusion that it was based upon Al Tizini, which was first published at Damascus in 1534. The paper was accompanied by notes, principally upon the Arabic names of stars. In conclusion Mr. Knobel asked the President to accept, on behalf of the Society, this MS. of Al Achsasi as a contribution to the Library.

*Prof. Turner.* I would suggest that, as Mr. Knobel has presented this valuable book to the library, there should be placed on the back of it a reference to this translation and to his paper, otherwise in years to come it will very likely involve some research to connect the book with the translation, and its value will be much impaired. Or it would perhaps be better still to have the book and its translation bound together in one volume.

A vote of thanks was accorded to Mr. Knobel.

*The President.* I see we have amongst us this evening a visitor from the Sister Isle, the period of whose orbit appears to be exactly one year. He comes to see us with a regularity which is quite charming. The only objection we can have is that that period is too long. I refer to Mr. Marth. I will not ask him to read his very interesting paper on the Ephemeris for Physical Observations of Jupiter, but I will merely ask him to make some remarks to us on his work.

*Mr. A. Marth.* The paper to which the President refers is on[illegible]on the beginning of the ephemeris; a larger portion will appear in the supplementary number of the 'Monthly Notices.' I should like to take this opportunity to appeal to those who have first-rate instruments to take advantage of the opportunity, which will occur in the year 1896, of making observations which will help to determine the position of the node of the 4th satellite of Jupiter. Twelve years ago I suggested that this should be done, and again six years ago I spoke of it, and now for the third time I ask for these observations. If such observations are not made next year we shall be compelled to wait for another twelve years, until the year 1909. Our knowledge of Jupiter's system is really in a most unsatisfactory state. Four years ago I wrote rather plainly on this subject, and I asked Mr. Turner whether he could give me information as to whether Prof. Adams had determined the mass of the 4th satellite of Jupiter from observations, or whether he had assumed that a certain coefficient is correct. It is most essential to know whether Prof. Adams got it from observation and not merely theoretically. I have a letter from Mr. Tebbutt, in Australia, who observed the eclipse of the 4th satellite on April 10th, when he says the observed duration of the eclipse was far shorter than that given in the 'Nautical Almanac.' This is the fourth or fifth eclipse which shows there is considerable error in the tables. I should be glad to know that someone is going to take up the matter.

It is a job which can only be taken up by some young man who is able to devote the leisure of 12 years to it. Prof. Adams worked at it for many years, and what is the upshot? This is a very serious matter. As regards the 5th satellite, up to this time only part of the determination of the orbit is possible, and this is from the observations of Prof. Barnard. No one in Europe has yet succeeded in seeing it. This is a very serious business.

*Prof. Turner.* I can only say that on receipt of Mr. Marth's letter I forwarded it with some additional appeals of urgency on my own part to Prof. Sampson, who is examining the MS. of the late Prof. Adams. I asked him what progress he had made in that examination, and he said he had disentangled such MSS. as related to the satellites of Jupiter, and was proceeding with other work, and the receipt of Mr. Marth's letter urged me to enquire whether those parts of Prof. Adams's works could not be published; and I understand from him that he will pay particular attention to this point, *i. e.*, the publication of such MSS. of Prof. Adams as relate to Jupiter at the earliest possible moment. I will reply to Mr. Marth's enquiry by an enquiry to himself, and that is, whether it would not be well to indicate to observers the particular phenomena, observations of which would be specially valuable for this purpose. Mr. Marth is indefatigable in publishing certain ephemerides every year, and their value is testified to all over the world; but if he could point out to observers to which phenomena out of the many he publishes it would be best to pay attention I think that some of us will not be so backward in helping in this matter as Mr. Marth implies. I say this because I feel that the connection between the man at the telescope who makes the observations and the man who uses those observations is not quite strong enough, and it would probably facilitate matters if Mr. Marth could tell the observer to which points it would be best for him to direct his energies.

*Mr. Marth.* What I specially want to know now is whether Prof. Adams assumed that a certain coefficient is correct, or whether he has really investigated the observations to determine that it is so. I think that is a very simple question to settle if you have the MS. before you. I promised Prof. Barnard three years ago to let him know as soon as I got the information, and I cannot answer his question.

*Dr. Downing.* It has been my duty to assist in the elucidation of some of Prof. Adams's researches on the satellites of Jupiter, and to read the proofs of some of his papers on the subject, and, so far as I remember, there is no comparison with observations; but, as Mr. Marth says, he has probably assumed a certain coefficient and determined the mass of the 4th satellite from that. That is all the information I can give on the subject. I think it would be advisable that astronomers should pay more attention to the satellites. I think valuable information could be gathered from micrometric measures of their positions.

*Mr. Marth.* I suggest that micrometer measures should be made of the position of the shadow of a satellite as it crosses the centre of the disc. In the continuation of the ephemeris I will give exact positions of the satellites, which observers may find more useful.

A vote of thanks was passed to Mr. Marth.

*Mr. Lewis* then read a paper "On the Diameters of Jupiter and Jupiter's Satellites observed with the 28-inch refractor at the Royal Observatory, Greenwich." He said that as soon as the telescope had been got into proper working order it was resolved to make a series of measures of Jupiter, and in particular of the diameters of the satellites, the polar and equatorial diameters to be measured on each occasion. So far as the measuring of the diameters of Jupiter were concerned, there appeared to be strong evidence of some personality between Mr. Dyson and himself, and also a difference depending on the power of the eyepiece used. The mean of Mr. Dyson's, Mr. Maunder's, and Mr. Lewis's measures gave for equatorial diameter 38″·407, and for polar diameter 36″·099, agreeing with Prof. E. Barnard's 38″·522 and 36″·112 respectively. These measures are just one second larger than Prof. Schur's measures made with a heliometer.

*Mr. Marth.* In my ephemeris 1895–96 I have used Prof. Barnard's results.

*Mr. Lewis* (continuing). The plan of work on the satellites was to observe both the equatorial and polar diameters on the same evening. A long series has been obtained and a slight prolate ellipticity of the first and second satellites of Jupiter is indicated, the polar diameter being the larger. It is satisfactory to find that recent measures are very accordant [see p. 285].

*Capt. W. Noble.* I assume, without actually knowing, that the instrument used at Greenwich is a filar micrometer. Mr. Lewis remarked that the measures made by Dr. Schur with the Gottingen heliometer differed in defect from those made at Greenwich, but Main's measures of Mars made with a double-image micrometer were in excess of those made with other instruments. Schur's and Main's observations are analogous to this extent, that they both depend essentially on the duplication of images; and the circumstance that in one case the results are comparatively large, and in the other case small, seems to me to require some explanation.

*The Astronomer Royal.* I think the best way of throwing light upon the point that Captain Noble has raised would be to make measures of diameter with a double-image micrometer, and in fact it had been arranged to make such a series of measures of Jupiter and his satellites. It was intended that these measures should be made as well as those with the filar micrometer. I agree that it is an extremely interesting question, and I hope next year we may have a good series of measures to show made with the double-image micrometer. A few such measures have been made, but the value of a revolution of the screw has not yet been determined. With reference to the interesting matter that the equatorial diameters of the satellites as measured are in all cases smaller than the polar, the explanation may be that the diameter is not actually smaller but that there is a deficiency of illumination in the equatorial region which apparently diminishes the breadth of the disc. The observations show, not certainly, but with some degree of probability, that the equatorial diameter is slightly smaller than the polar in the case of the first and second satellites.

*Mr. Lewis.* I think Capt. Noble will find that in the case of double stars, measures with the double-image micrometer or with the heliometer all give large results comparatively.

*Capt. Noble.* I know by experience the exceeding difficulty there is in making contact of two images of limbs of the Sun. For my own personal use I should prefer the filar micrometer. I should feel more certain of the results.

*The President.* The questions raised are extremely interesting. The one thing which to my mind is worthy of particular notice is that at last we have got a telescope at Greenwich that is capable of doing something in the way of measurement. (Hear, hear!) I think we ought to congratulate the Astronomer Royal upon the very successful result of his labours in getting this telescope. There is no doubt it is capable of doing extremely good work, and, notwithstanding all that is said against the English climate and the climate of Greenwich, I feel that in future we shall get most excellent results from this particular instrument.

*Mr. Maunder* read a communication from Prof. Keeler and showed the photograph accompanying it—an enlargement of the actual photograph of the spectrum of Saturn and his rings, showing the varying displacement of the lines owing to the independent rotation of the particles of the ring. Earlier attempts had been made by Prof. Keeler, when he tried unsuccessfully to photograph the spectrum in the region of the ultra-violet. Now he has used ortho-chromatic plates and has obtained successful photographs of the lines in the yellow and orange. Remembering that the eastern limb of the ball is approaching us and the western limb receding from us, the spectrum lines are displaced at either end in opposite directions, and thus slant slightly across the spectrum. If the ring rotated as a rigid body rigidly connected with the ball, the lines of the spectrum of the ring should be shown as a prolongation of these slant lines, but this the photograph does not show. The lines of the spectrum of the ring show a slight inclination as compared with those of the ball, and from thence it may be inferred that each particle of the ring is travelling in an orbit of its own.

*Capt. Noble.* It seems to me, Sir, that Prof. Keeler has enabled us to walk by sight, whereas hitherto we only walked by faith.

Prof. Keeler, like Foucault with his pendulum, has enabled us to absolutely see, as it were, the separate particles of the ring in rotation, and I think that our special thanks are due to him.

A vote of thanks was accorded to Prof. Keeler for his paper.

*Prof. Turner* exhibited photographs sent by Prof. E. E. Barnard and read the papers which accompanied them on (1) a Photographic Study of the Earth-lit portion of the New Moon, and (2) A great Photographic Nebula in Scorpio near Antares.

A vote of thanks was accorded to Prof. Barnard for his photographs.

*The President* then called upon Prof. Michie Smith, Director o the Madras Observatory, to give the Society some account of hi work at Madras.

*Prof. Michie Smith.* I find it a little difficult to know what t say to-night which will be of interest to this Society, for my wor since I have had charge of the Madras Observatory has bee chiefly the bringing up of arrears of publication of meridian obse vations. Mr. Pogson, who, as you all know, was an astronom thoroughly devoted to his science, unfortunately met with diff culties in the way of publishing his results, which led him devote almost his whole time to observing. Three or four yea before his death, arrangements in which I had a hand were ma to facilitate publication, and the last three or four years of his l were spent at this work. But it is no easy matter to bring up date 30 years of arrears, and he had only made a beginning. have continued this work, and have published the 30 years' obse vations, and it now only remains to publish the catalogne deduc from them. The Right Ascensions of the Catalogue will, I thi be very trustworthy, but I am sorry that I cannot say the same the Declinations. The facts that the latitude of Madras is accurately known and that the division errors of the circle h not been determined will cause some delay in completing work. A more interesting subject that I can speak about the new observatory which is to be built in the Palani Hills, which the money has already been voted by the Government India. It is proposed to establish a Solar Physics observatory Kodaikanal, 300 miles south of Madras, and I hope that by t time the building has actually begun. The programme of work a very modest one. We propose to take over the daily work photographing the Sun, now carried on at Dehra Dûn by officers of the Indian Trigonometrical Survey. We also prop to carry on a thorough system of spectroscopic examination of Sun. The details of this have not yet been settled, but I hope the result of my visit home, to get the support of astronomers as to urge the Indian Government to give us a thoroughly powe solar spectroscope. The site we have selected promises to admirably suited for such work. The mean daily temperat varies from 54°·1 in December to 62°·2 in May, and the m temperature of the year is 58°·5. The rainfall in the year in which we made special observations was 47½ inches, which is rather under than over the average for previous years. The bright sunshine from March to December amounted to 1634 hours, which is, I think, rather more than the record for most parts of the world. But the great feature, which will be so advantageous, is that almost all the cloud happens during the middle part of the day—that is to say, the morning is almost always bright up to 11 o'clock or half-past; then the clouds come up and continue until about 4 o'clock. Usually by 6 o'clock the sky is cloudless. A night which is cloudy all through is almost unknown except during the N.E. monsoon. The nebula near $\eta$ Argûs, as seen from the altitude of the chosen site, is such a brilliant object to the naked eye that there is no possibility of failing to see it, from which it may be judged what a very excellent atmosphere we shall be in.

*Prof. Turner.* I must express my pleasure at hearing of these splendid prospects for doing spectroscopic work. I have no doubt that the experience lately thrust on Prof. Michie Smith, rather against his will, in reducing the transit observations will be of much value to him in his future work, in which we wish him every success.

*Capt. Noble.* There is a great fascination about spectroscopic astronomy. It is to be hoped that Prof. Michie Smith will still continue the meridian work to some extent.

*The President.* Prof. Michie-Smith has certainly given a hostage to fortune in the description he has given us of the climate of Kodaikanal. There seems to be little left to be desired from an astronomical point of view. The only difficulty one can anticipate is that the observer may get tired of his work. Continued cloudless sky is such a rare experience in England that here there is no opportunity of such a contingency. We shall look forward to the Madras observations with intense interest, and I hope that Prof. Michie Smith, having got rid of the incubus of having to reduce another man's observations, will find himself able to do a great deal of work, and will be able to induce the Government to furnish everything that is necessary.

*Mr. G. M. Seabroke*, in presenting the measures of double-stars made by himself and Mr. Highton, gave a short account of the equipment and the work done at Rugby Observatory [see p. 238].

*Miss A. Everett* read a note on the binary star $\iota$ Leonis. She said that there was some reason for thinking that the apse of the apparent orbit had been passed, and therefore she had made an examination of recent measures, from which it appeared that maximum apparent distance had been passed somewhere about 1880, and that the companion star would shortly be moving more rapidly in its orbit. Having this in view, it seemed worth while to call the attention of observers to this star, which may shortly be in a more favourable position for observation.

The following papers were announced and partly read:—

*E. E. Barnard.* "On a Photographic Study of the Earth-lit portion of the New Moon."

*E. E. Barnard.* "On a great Photographic Nebula in Scorpio, near Antares."

*W. T. Lynn.* "Note on the Proper Motion of Arcturus."

*W. F. Denning.* "Observations of Jupiter."

*R. H. M. Bosanquet.* "The Star Survey by Fixed Co-ordinates in the Southern Hemisphere; with a Proposal for Co-operation."

*R. M. H. Bosanquet.* "The Relation between Precession and Proper Motion."

*T. J. J. See.* "A General Method for Facilitating the Solution of Kepler's Equation by Mechanical Means."

*T. J. J. See.* "Elements of the Orbit of 25 Canum Venaticorum."

*Prof. T. H. Safford.* "The Accuracy of Late Catalogues of Declinations of Standard Stars."

*A. Marth.* "Ephemeris for Physical Observations of Jupiter, 1895–96."

*J. E. Keeler.* "Photograph of the Spectrum of the Ball and Ring of Saturn."

*W. G. Thackeray.* "Meridian Observations of Sirius and Procyon, made at the Royal Observatory, Greenwich, 1836–94."

*E. B. Knobel.* "On a Catalogue of Stars in the Calendarium of Mohammed Al Achsasi Al Mouakket."

*Miss A. Everett.* "Note on the Binary Star ι Leonis." Communicated by T. Lewis.

*Royal Observatory, Greenwich.* "Diameters of Jupiter and Satellites."

*E. J. Stone.* "A Determination of the Mean N.P.D. 1790 Jan. 0 of γ Draconis from Observations made at Oxford by Dr. Horsley."

*G. M. Seabroke & H. P. Highton.* "Further Measures of Double Stars made at the Temple Observatory, Rugby."

*Prof. H. H. Turner.* "On the Angular Distance of two Stars in the Pleiades suitable for Determining the Value of a Micrometer Screw."

The following gentlemen were elected Fellows of the Society:—

*Rev. J. Dunne-Parker, LL.D.*, Bennington House, Stevenage, Herts; *John A. Ferguson*, Newlands, Oak Hill, Surbiton, S.W.; *George Andrews Hill*, United States Naval Observatory, Washington; *Ernest William Hobson*, Christ's College, Cambridge.

The following Candidates were proposed for election as Fellows of the Society:—

*Major Kingley Foster*, Shenley, Redhill, Surrey (proposed by Sir R. S. Ball).

*Rev. Henry A. Hall*, M.A., Totnes Grammar School, Devon (proposed by E. J. Stone).

*Richard Llewelyn Jones*, M.A., Professor of Physics, Presidency College, Madras (proposed by C. Michie Smith).

*Herbert Savery*, M.A., Assistant Master at Marlborough College, Wilts (proposed by R. A. Sampson).

---

## THE BRITISH ASTRONOMICAL ASSOCIATION.

The seventh ordinary meeting of the current session of the British Astronomical Association was held at University College, Gower Street, on Wednesday, May 29, Mr. E. Walter Maunder, President in the Chair.

Among the presents announced was a gift of 84 volumes from Mr. Criswick for the library.

*The President* announced that the members of the Jupiter Section had asked him to present on their behalf, to the Rev. W. R. Waugh, the director, a handsomely bound copy of Dr. Roberts' beautiful book, 'Photographs of Star Clusters and Nebulæ,' as a small token of their esteem and regard.

*Miss Everett* stated that the Rev. E. Ledger had forwarded some suggestions with regard to the solar eclipse expedition of 1896. He stated that the eclipse as a spectacle might be very well seen from Bodö on the western coast, but he strongly advised all those who intended to do really scientific work to go to Vadsö on the eastern coast. He further urged the desirability of chartering a special steamer, as both the steamers and hotels would probably be crowded with ordinary tourists desirous of seeing the eclipse. He thought, further, that a view of the midnight Sun could not conveniently be combined with the expedition.

*Col. Burton-Brown* gathered that it was contemplated that the Association should have two spheres of operation—the west as well as the east coast. He quite agreed that the west coast should not be ignored as, given a clear sky, some very useful observations might there be secured. He urged that early information should be given by intending observers as to the kind of work they proposed to undertake, and that a little training should be given when on board to those willing to undertake special work.

*The President* urged the desirability of as many as possible sending in their names with particulars as to the time they would have at their disposal, the instrument, if any, they proposed to take, and the work they suggested doing. He hoped many would not be content with viewing the eclipse as a spectacle, but would go with the intention of doing real solid work.

*Miss Everett* read a paper by *Prof. H. H. Turner* "On a simple Apparatus for Measuring Stellar Photographs," in which he said that various forms of micrometers had been proposed for the measurement of position of objects on the photographs, but the simplest of these, which would be used in large observatories, would cost at least £20. Suggestions for reducing an item of expenditure of this magnitude would no doubt therefore be welcome. A réseau was almost indispensable, but the expense of one was serious. His suggestion was that the Association should purchase a réseau or réseaux and supply photographic copies to the members. A microscope was of course necessary for actual measurement, but that was not difficult to supply, and all that was necessary in addition was a small scale in the common focus of the objective and the eyepiece. Prof. Turner described the method of making such a scale photographically, and urged that the cost of a complete outfit for taking and measuring the stellar photographs was within the resources of anyone, and that there was at the present time unlimited scope for useful work in this direction.

*Dr. Downing* thought the present a suitable opportunity for renewing the suggestion he had made in his Presidential Address for the formation of a Section for the purpose of carrying out photographic work in astronomy. They had several isolated workers in this field, and if they would only combine the Council would no doubt be quite ready to take the necessary steps for the formation of a Section without delay.

*Mr. Edwin Holmes* read a paper on "Reproduction of Astronomical Drawings, &c." Mr. Holmes urged that all discussion of reproduced drawings was only wasted time unless they could rely upon accurate copying. No doubt many differences were due to difference of seeing and drawing and to the use of too small instruments, but he had been driven to the conclusion that the wood-engraver and the lithographer had often their own ideas as to how a planet ought to look and touched up the work they had to reproduce. The personal equation of the observer they could not hope to eliminate, but they could get rid of the more objectionable personal equation of the lithographer by adopting the Collotype process.

*Mr. N. E. Green*, referring to a remark of Mr. Holmes', said that there was the most evident proof from the various drawings of Jupiter of a change in the latitudes of the belts. He added that all his views were made at the telescope and never touched afterwards, but it was beyond the powers of eye and hand to repeat a drawing without some difference.

*Mr. W. H. Maw* agreed with Mr. Holmes as to the value of the Collotype process for accurate reproduction of drawings, but pointed out that such drawings must be in a suitable monochrome. There was also the practical impossibility of getting clear whites, such as the bright spots on Jupiter, by the processes Mr. Holmes recommended.

*Mr. Green* remarked that when he wanted a photograph of one of his drawings he always made a special copy in black and white. Any trace of yellow or orange in the paper made a satisfactory photograph impossible.

*The President* said that some of the illustrations in past Lunar Reports were produced entirely by photography.

*Mr. Maw* said that the process used in those reports was the Meisenbach not the Collotype.

*Mr. Petrie* read a paper by *Mr. W. H. S. Monck* on "The Spectra and Colours of Stars." Mr. Monck suggested that possibly a relation might be discovered between the spectra and colours of stars which would enable an experienced observer to predict the spectrum from the colour. He had examined the two reports of the Star Colour Section with this object, and had found that in some cases the connection seemed pretty clear, but much greater accuracy in defining the colours would seem to be necessary if any practical work was to be accomplished.

The third report of the Lunar Section by *Mr. T. G. Elger* was presented and extracts from it were read by *Miss Everett.* Special reference was made to some remarkable observations by Herr Leo Brenner, particularly in the neighbourhood of Hyginus N, which, if confirmed, pointed to extensive local changes within recent years. Fair progress was being made with the chart of Ptolemaeus, and Mr. Maw's measures published in the last report had proved of great value. More observers with large telescopes were greatly needed.

Among the exhibits at the meeting were two albums of drawings by Herr Brenner of Jupiter and Mars, exhibiting a remarkable amount of fine detail.

A Special General Meeting was held after the Ordinary Meeting, at which some amendments to the Rules, with the object of simplifying the election of the Council, were considered and adopted.

---

## ROYAL METEOROLOGICAL SOCIETY.

THE last Meeting of this Society for the present Session was held on Wednesday evening, June 19th, at the Surveyors' Institution, Westminster, Mr. R. Inwards, F.R.A.S., President, in the Chair.

Mr. R. H. Curtis read a paper on the "Hourly Variation of Sunshine at seven Stations in the British Isles," which was based upon the records for the ten years, 1881–90. Falmouth is decidedly the most sunny station of the seven, having a daily average amount of sunshine of 4½ hours. This amount is half an hour more than that recorded at Valentia, and three-quarters of an hour more than at Kew. Of the other four stations, Aberdeen, the most northern, but at the same time a coast station, with 3·64 hours, has more than either Stonyhurst or Armagh, both inland stations; whilst Glasgow, with only 3 hours, or about a quarter of its possible amount, has the smallest record of the seven, a result to some extent due to the nearness of the observatory to the large manufacturing works with which the city of Glasgow abounds.

At Valentia, Kew, Stonyhurst, and Armagh, the maximum duration is reached in May, the daily mean amount varying in the order named from 6·75 to 6 hours. At Falmouth and at the Scotch stations the increase goes on to June, when the mean duration at Falmouth reaches 7·5 hours, at Aberdeen 6·25 hours, and at Glasgow 5·6 hours. January and December are the most sunless months of the year. The most prominent feature brought out at all the stations is the rapid increase in the mean hourly amount of sunshine recorded during the first few hours following sunrise, and the even more rapid falling off again just before sunset.

Mr. H. Harries read a paper on the "Frequency, Size, and Distribution of Hail at Sea." The author has examined a large number of ships' logs in the Meteorological Office, and finds that hail has been observed in all latitudes as far as ships go north and south of the equator, and that seamen meet with it over wide belts on the polar side of the 35th parallel.

---

## *Variation of Latitude**.

On the recommendation of the Board of Trustees of the Watson Fund, the Academy last year unanimously awarded the Watson Medal to Seth C. Chandler, of Cambridge, Mass., for his investigations relative to variable stars, his discovery of the period of variation of terrestrial latitudes, and his researches on the laws of that variation. It is the pleasant duty of the Trustees to set forth the grounds on which this award was recommended.

It is a result of the well-known laws of dynamics relating to the rotation of a rigid body, as the Earth is assumed to be, upon its axis, that the poles of the Earth may be determined in two ways. Our globe, being a spheroid flattened at the poles and protuberant at the equator, has a certain axis passing between the points of greatest flattening. This axis has no direct connection with the rotation of the Earth; it would exist if the latter, retaining its present form, did not rotate at all. It is called the axis of figure, being determined altogether by the shape of the Earth.

But the Earth has also an axis around which it rotates. Now, assuming the Earth to be a rigid solid, there is no necessity that the axis of rotation should correspond to that of the axis of figure just described. We could take a solid body, pass an axis through it in any direction, and make it rotate on that axis.

It was shown by Euler, more than a century ago, that if a solid body rotated on an axis different from that of figure, the position of the axis of rotation in the body would be subject to a slow change, consisting in a constant revolution around the axis of figure. Were this body the Earth, the latitude of a place, as determined by astronomical observation, would change in the same way. The time of one revolution of the pole would depend upon the figure of the Earth. The flattening of the Earth is such that, were it a perfectly rigid body, the time of revolution would be about 305 days; that is to say, the north pole would make its circuit in a period of 305 days.

---

* Report of the Watson Trustees to the American National Academy of Sciences. (From 'Science,' 1895, May 3.)

There being no necessity that the two poles should coincide, the question was naturally raised whether, perhaps, there might actually be such a difference of the two poles, and, in consequence, a change of latitude of every place on the Earth's surface having a period of 305 days. The first to investigate this question with all the refinements of modern astronomy was C. A. F. Peters, who, half a century ago, was an assistant at the Pulkowa Observatory. In his classic paper on the parallax of the fixed stars, one section is devoted to the question of the variability of the latitude in a period of 304 days, which, according to the then accepted value of the flattening of the Earth, would be the time of one revolution of the poles. He found a coefficient of 0''·079, with a probable error of 0''·017. This result was so extremely minute that it might have arisen from unavoidable sources of error; and the conclusion therefore reached was that if there was any such separation of the two poles, it was too small to be certainly detected by the most refined observations.

In 1862 our late fellow member, Professor Hubbard, of the Naval Observatory, commenced a series of observations with the prime-vertical transit of that institution, which would be available for the same research. They were interrupted after a little more than a year, by his untimely death, but were continued four years longer by his successors. The result was the same as that reached by Peters; no change having a period of 305 days could be detected.

In 1873 the question was investigated by Nyrén in connection with a longer series of observations on the latitude of the Pulkowa Observatory. His results were somewhat discordant, and the only conclusion that could be drawn from them was that the variation could not be certainly detected by these most refined observations.

Ten years later Nyrén repeated the determination, in connection with his observations for the determination of the constant of aberration. These observations, made with the prime-vertical transit, were carried through with the minutest attention, and the utmost care to avoid every conceivable source of error. Curious discordances were nevertheless found in the results for the constant of aberration.

In 1885 Küstner showed that they could be accounted for by supposing a change going on in the latitude. But nothing could be inferred respecting the law or the cause of the change.

As a result of these investigations, the coincidence of the Earth's axes of rotation and of figure has, until within a very few years, been assumed by astronomers as a practically established fact; and all their methods of observation have rested upon the idea of absolute coincidence. This confidence has not been disturbed until within a few years, when the question has been reopened. But it has now apparently been settled upon a new and firmly established basis.

Dr. Chandler's work upon this subject began with observations made by him in 1884–85, using a novel form of astronomical instrument of his own invention. These observations, continued uninterruptedly for thirteen months, revealed a progressive change of a pronounced periodical character in the instrumental values of the latitude. In publishing these results in 1885 he announced his intention to continue the research throughout the remainder of that year. Yet circumstances prevented him from carrying out his intention at that time, and he did not resume his examination of the subject until six years later. Meanwhile Dr. Küstner, at the Observatory of Berlin, in 1888, published a memoir on the Constant of Aberration, as deduced by him from a series of observations also made in 1884–85, simultaneously with Chandler's series, which brought to light anomalies of an entirely analogous character. Küstner's series was not continuous enough to show the periodic nature of the phenomenon; but, by an exhaustive examination of the possible subjective sources of error, he clearly demonstrated that it was no longer permissible to retain the hypothesis of an invariable position of the pole, and he recommended that properly organized observations at various places be instituted to settle the question definitely. It was doubtless this work of Küstner's which compelled the attention of astronomers to the subject. As a result, by the coöperation of three German observatories, under the auspices of the International Geodetic Association, and the independent action of that at Pulkowa, the fact of the variability of terrestrial latitude was placed beyond question, and, by a corresponding series made at the Sandwich Islands, the further fact was established that the variable element is the position of the axis of rotation with respect to the Earth's body, and not its position in space.

It was just before this point that a renewal of Chandler's connection with the problem began. The results are published in a series of eighteen papers in the 'Astronomical Journal' (1891–94), exclusive of a series of five papers upon a topic closely related thereto, and involving it; namely, the aberration-constant, which will be separately spoken of later.

The keynote of these investigations, and the undoubted cause of the success which has attended them, lies in the fact that at the outset he first recognized the necessity of deliberately disregarding all teachings of the adopted theory, which had misled previous investigators, and of examining the facts by a purely inductive process, taking nothing for granted, and basing all conclusions strictly upon the observations themselves.

It is impossible to give here more than a bare statement of the principal results thus established, which we arrange in their natural order, and not in the historical order of their derivation.

1. The phenomenon is not a local or a regional, but a terrestrial one; also it is a displacement of the Earth's axial rotation with reference to the principal axis of inertia, and not of the direction of the former in space.

2. The axis of rotation, although fixed as regards its direction in space, performs a relative revolution about that of inertia in a period of 428 days. This motion is circular, with an average radius of about fourteen feet, and its direction is from west to east.

3. Simultaneously with the above motion, the actual position of the principal axis of inertia on the Earth's surface is in motion about a mean position, in a period of a year. Its direction is also from west to east, but is in an ellipse, three or four times as long as broad, the major and minor axes being about twenty-five feet and eight feet respectively. The major axis is inclined at present by about 45° to the Greenwich meridian. The motion is central, obeying the law of proportionality of times to areas described by the radius vector about the centre of the ellipse.

4. Both the radius and period in the circular 428 days' revolution are systematically variable; the former between about eight feet and eighteen feet, the latter between about 423 and 434 days; in a long period of apparently about sixty-six years. In this inequality of motion the average angular velocity is attained when the size of the circle is least or greatest when the circle has its mean dimensions.

5. Similarly there are simultaneous changes in the apparent dimensions and velocity in the annual period, which are complementary in their character to those in the 428 days' revolution; but whether they are the result of real changes in the form and dimensions of the ellipse, or the effect of an apsidal motion of long period, cannot at present be determined from the observations available. All that can be said is that observations during five years show that the line of apsides is either fixed, or, if variable, revolving only at a very slow rate.

6. Besides these two motions of relatively short period, there is distinct evidence of a third motion of rotation in a much larger term, probably not far from twelve years, with a radius of ten or fifteen feet, which reconciles similar indications of slow changes which had been pointed out by other investigators. (A. J., xii. 178; xiii. 35, 36.)

The results thus established are the outcome of the examination of an immense number of observations, covering the whole interval since the era of refined practical astronomy began, and in fact practically exhaust the materials which may be drawn for this purpose from existing astronomical annals. The endeavour to

make the discussion exhaustive in this respect made it necessa
to completely reduce, from the original instrumental reading
extensive older series of observations. It has, incidentally, f
example, rescued from almost complete oblivion the series of Pon
1825–36, and shown that work to be of a character which w
compare favourably with the most refined observations made wi
the meridian instruments of the present day.

Intimately connected with the work on the variation of latitu
are five additional papers, containing a redetermination of t
value of the aberration-constant from eight different series
observations at the Pulkowa Observatory, with the prime vertic
transit and the vertical circle. The correct value of this fund
mental element is one of the most important questions occupyi
the astronomy of the day.

---

## *Fireball.*

On June $10^d$ $9^h$ $59\frac{1}{2}^m$, a very fine meteor was observed by Mr.
Booth and Mr. H. J. Townshend at Leeds, and by Mr. D.
Packer at Birmingham. I am indebted to Mr. H. Cord
(Director of the Meteoric Section of the B.A.A.) for two of the
observations; and as the fireball displayed some interesting as w
as brilliant features, it seems to deserve comment.

Mr. Booth estimated it as 5 × ♀, and describes it as clu
shaped, with a duration of flight of 5 seconds. Before disappea
ance it exploded into three parts. Path from 251° +40° to 24
+66°.

Mr. Townshend says he first "caught sight of the meteor wh
it was near ε Herculis, and sailing slowly in a straight line
η Draconis, emitting sparks all the way; and when just und
η Draconis it suddenly expanded into a large and brilliant obje
the head and body being a bright blue colour, while the narr
part behind was blue, red, and violet. The magnitude was abo
8′ vertical diameter, and about 30′ horizontal. Duration of flig
6 seconds. Observed path 253° +33° to 242° +65°."

Mr. Packer describes it as passing "about ½° above α Cygni
γ Cassiopeiæ, which it momentarily eclipsed, and disappeared
double the angular distance between those stars. Motion slo
duration 3 or 4 seconds, during which it traversed an arc of abo
85°. Brightness at max. 4 × ♀ ; nucleus varied considerab
during passage. Tail yellowish white; nucleus of meteor ve
intense white at moment of greatest brightness, which occurr
about 10° beyond γ Cassiopeiæ."

Comparing these descriptions I find the meteor probably beg
at a height of about 58 miles above a point 8 miles N.W.
Spalding, and ended at an elevation of 44 miles when 12 mil
N.E. of Leeds. Real length of path 89 miles; Earth point, La

Moyley, on N. border of Inverness. The Leeds observers did not see the beginning of the meteor, so I have chiefly relied upon Mr. Packer's position; but for the end point I have accepted the two reports from Leeds, as they mutually corroborate each other, and intimate that Mr. Packer's path of 85° is much too long. Additional observations would be of great service in testing the accuracy of these deductions.

The radiant-point of the meteor was at 259° −23° near θ Ophiuchi, and on the ecliptic about 13° E. of Antares in Scorpio. I have on several occasions called attention to this region as a special one for fireball-radiants in the summer months. Von Niessl has determined the radiants of 5 large fireballs seen respectively on 1883 June 3 (2), 1878 June 7, 1873 June 17, and 1879 July 13, as about 7° N.N.E. of Antares. Prof. Herschel found a radiant for the fireball of 1876 July 25, at 258° −24°, and for that of 1864 Aug. 10, at 238° −27°. For the fine meteor of 1889 Sept. 25, seen at Bristol and Oxford, I derived a radiant at 244° −22°.

It will be noticed that Prof. Herschel's position for the radiant of the fireball of 1876 July 25 (258° −24°) is remarkably near that (259° −23°) derived from the path of the similar object observed on June 10 last; but some of the other positions are 10° west. One of Heis's radiants deduced from Neumayer's observations in the S. hemisphere is at 258° −20, July, thus confirming the fireball-radiant.

I have never seen a well-defined shower of ordinary shooting-stars from Scorpio in June or succeeding months; but in 1886, April 30 to May 7, I recorded some fine long meteors from a sharply-defined radiant at 254° −21°. This position agrees very well with that of the group of fireball-radiants manifested in later months in the year.

Bristol, 1895. June 22. W. F. Denning.

## *Selenographical Notes.*

The Palus Putredinis and the Clefts West of Archimedes.—The abnormal darkness of portions of the western side of the Mare Imbrium, especially of certain areas near the flanks of the Apennines, is a phenomenon familiar to most observers, and is, moreover, evident in any good photograph representing the Moon under a moderately low Sun. From the time of Hevelius downwards, scarcely any lunar chart, however rough, omits to indicate the existence of the most dusky of these areas, which, it may be presumed, by reason of its sombre tone and fancied resemblance to a low-lying swamp, was named the Palus Putredinis. It extends from the foot of the western *glacis* of Archimedes to the escarpment of the Apennines in the Mt. Bradley region, its limits both on the north and south being roughly parallel and distinctly defined by higher and brighter ground. Though it is difficult to advance a feasible hypothesis to account for this and other similar dark expanses, perhaps the least objectionable is to regard them as former drainage-areas where the material accumulated is of a low reflective power and of a somewhat different character from the remainder of the neighbouring Maria. However this may be, the telescopic examination of this particular "Palus" reveals much that is interesting, if it is made about the time when Archimedes is not far removed from the morning or evening terminator.

The most conspicuous feature in connection with this formation is the massive wedge-shaped spur projecting many miles beyond its limits on the south-west. The bright western flank of this object descends steeply to the Palus, its boundary forming a very regular curve, concave on the west, which ultimately appears to join the outer slope of the wall. If examined, however, under a low Sun, it is clear that this curved strip forms the eastern side of a nearly perfect ring, the western portion of which consists of low ridges, the whole defining an incomplete enclosure, some 25 miles in diameter, apparently a partially destroyed formation, open towards the west, on which side a wide and very shallow valley extends up to groups of outlying mountains bordering the base of the Apennines. Near the southern limits of this hollow lie the clefts marked χ and χ 2 in Neison's map of the district, which, running towards the south-west, ramify among these isolated elevations and ultimately cross other clefts trending in the direction of the great mountain range at no great distance from its foot. Of these, the more northerly, χ, is not straight, as shown by Neison, but very serpentine, being apparently diverted from its course in more than one place by local irregularities of the surface and exhibiting considerable variations in width and depth, till it is lost amid the hills on the eastern side of the wedge-shaped spur on the south-west wall of Archimedes. Before it reaches this, however, it is approached by another cleft, χ 3 in Neison's map, running from the foot of the western side of the spur. This is an object of a particularly interesting character. Neison draws it as actually joining χ and as practically straight and uniform in breadth. Observing it between $9^h$ and $10^h$ on May 31, when the morning terminator lay a little east of Archimedes, I noted that it follows a very winding course over this portion of the Palus, and that, moreover, in two places it expands into spindle-shaped depressions, recalling the lakelets associated with the river-beds described by Prof. W. H. Pickering in the recently published 'Annals' of the Harvard College Observatory. These were beautifully distinct with a power of 340 on my 8½-in. reflector. With all attention during spells of best definition, I could not discern the junction of χ and χ 3. The latter seemed to die out before reaching χ. In a fine enlargement of Archimedes from a

Lick photo, dated 1893, August 3, $15^h\ 23^m\ 13^s$ P.S.T., for which I am indebted to the courtesy of Dr. L. Weinek, the course of this cleft, as also that of $\chi$, is traceable; and still more plainly in a photograph taken at Arequipa by Prof. Pickering (Harvard 'Annals,' plate vi. fig. 1) under a more favourable phase for showing it. In both these productions the obscure ring referred to above on the west side of Achimedes is very distinctly indicated, as it is also in the reproduction in 'Knowledge' of a photograph of the Moon 240 hours old by MM. Henry, though in this the rills cannot be distinguished. Other recent observations of the clefts in this region must be deferred to a future occasion.

Cleft traversing the South Side of Firmicus.—Since the publication of my notes in the June 'Observatory' relating to this object, I have received the following communication from Miss M. Ashley, of Bath:—"The rill crossing Firmicus to which you refer, I saw again on Oct. 9, 1881, when the terminator was close to the west side of Firmicus. My sketch of that date shows it filled with dense shadow, only part of the walls appearing, and the rill crossing the south-eastern wall and extending as a narrow straight line of shadow in a north-easterly direction, passing close to a crater on the eastern side of the formation. It ended at some of the mountains with which this region is covered. The night before this (Oct. 8) the rill was not visible, but in its place on the floor was a rather large diffused white spot."

Beaumont House, Shakespeare Road,
Bedford, 1895, June 19.

T. Gwyn Elger.

---

# CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

## *Naked-eye Views of Mercury.*

Gentlemen,—

I saw Mercury, with the naked eye, on the six evenings May 26, June 1, 2, 5, 6, and 7; but he was not a conspicuous object at any time. I also observed the planet on May 30 with a field-glass, but he appeared very faint amid thin films of stratus cloud lying along the W.N.W. horizon, and was quite invisible to the unaided eye. I have frequently seen Mercury under a more brilliant aspect during those easterly elongations which have occurred at a much earlier period of the year.

Jupiter, being in the same region of sky as Mercury (conjunc-on took place on June 8, $4^h$, ☿ 0° 47′ N.), afforded an excellent uide to the position of the latter, especially on June 5, 6, and 7. elatively to Jupiter, however, Mercury was extremely faint, ough I have sometimes noticed (as in February 1868) the latter ining almost as brightly as the former. But the glow in the western sky is so strong after sunset in June that it must necessarily detract from the apparent lustre of any object situated in that region. This would, however, affect the appearance of Jupiter as well as Mercury, and I did not expect to find so great a difference in the brightness of the two objects, but other conditions were probably involved. Yours faithfully,

Bristol, 1895, June 15. W. F. Denning.

## *Heis's Meteor Radiant T.*

Gentlemen,—

I cannot but think that Heis's Radiant T includes more than one radiant, and I doubt whether any of them is connected with a comet. The R.A. of one of these radiants seems to me to differ at least 20° in R.A. from that of another. The first radiant is, I think, indicated by the following, independently of Heis:—

| | R.A. | Dec. | |
|---|---|---|---|
| Denning (from Italian obs.) ...... | 343° | +16° | May 26–June 13. |
| Schmidt .............................. | 335 | +10 | June. |
| Tupman .............................. | 338 | +13 | June 28. |
| Denning (from Italian obs.) ...... | 344 | +12 | June 26–July 11. |
| Sawyer (2nd Catalogue)............ | 338 | +18 | July 13–24. |
| Corder .................................. | 333 | +12 | July. |
| Denning (from Italian obs.) ...... | 334 | +12 | July 15–Sept. 14. |
| " " ...... | 337 | +14 | July 15–Aug. 2. |
| " (Catalogue) ............... | 338 | +10 | July 12–17. |
| " " ............... | 333 | +12 | July 18–23. |
| " " ............... | 333 | + 9 | July 26–Aug. 2. |
| " " ............... | 330 | +10 | Aug. 7. |
| " " ............... | 343 | +12 | Aug. 4–12. |
| Greg (Catalogue).................... | 344<br>to<br>327 | +12<br><br>+10 | July 22–Aug. 10. |
| Schmidt .............................. | 338 | +17 | August. |
| Tupman .............................. | 330 | +12 | Aug. 20, 25. |
| Denning (stationary meteor)...... | 337 | + 9 | Aug. 16. |
| " (Catalogue) ............... | 343 | +14 | Aug. 23. |
| " " ............... | 347 | +15 | Aug. 20, 24 |
| Herschel (Fireball Radiant) ...... | 338<br>340 | +10<br>+17 | Aug. 26. |
| Tupman .............................. | 345 | +13 | Sept. 7–15. |
| Herschel (Fireball Radiant) ...... | 345 | +20 | Sept. 25. |
| Schmidt .............................. | 337 | +20 | Sept. 1–10. |
| Corder .................................. | 334 | +15 | Oct. |
| Schmidt .............................. | 347 | +14 | Oct. 18–27. |

It is very difficult to fix the limits of this radiant, for there are others differing very slightly in R.A. or in Declination from those given above. But if the R.A. is carried on to 360° we get perilously near a well-known and long-enduring radiant at about 5° +12°. I think, however, that the above figures indicate no real shifting of the radiant between May and October. The changes, both in R.A. and Declination, follow no fixed law, and appear to arise either from ill-defined radiants or errors of observation; and the connection between such a long-continued and badly defined shower with any comet seems to me more than doubtful.

There are indeed families of comets which might give rise to the appearance of a long-enduring shower if each of them had its own train of meteors; and I find that Prof. Herschel gives the radiant of the Comet 1822 III. at 342° +14° for June 30 and that of the Comet 1770 II. at 349° +12° for July 13. But many more comets than these would be required to continue the shower during the months of August, September, and October.

Astronomers have, I think, been carried away by three or four very striking coincidences between meteor-radiants and cometary orbits. The general facts appear to be:—1. The great majority of radiants cannot be connected with any known comet; 2. The great majority of comets cannot be connected with any known radiant; 3. The great majority of meteor-radiants continue to be active without any substantial change in position for a period too long to be explained on the cometary theory.

Truly yours,

Dublin, 1895, June 6. W. H. S. Monck.

## *Lamont's Observations of Neptune.*

Gentlemen,—

In the account of Lamont in the 'Dictionary of National Biography,' we are told that he unconsciously observed Neptune twice, in 1845 and 1846. This is also stated in Arago's 'Astronomie Populaire,' and is the truth, but not the whole truth. The recognition of the fact is due to Dr. Hind, and was published in the tenth volume (p. 42) of the 'Monthly Notices of the R. A. S.' In the eleventh volume (p. 11) he remarked that he had overlooked a third; possibly this may have been partly caused by an error of an hour (20 for 21) at the top of the column in Lamont's Zones. Two observations of the planet, then, were made in 1846, on the 7th and 11th of September respectively. It is very remarkable that these dates are a few days after Le Verrier had read (on August 31) his last famous paper in the 'Comptes Rendus' of the French Academy, in which he so closely fixed the place of the then hypothetical planet which was disturbing the motions of Uranus. But Lamont could not at the time have seen that paper, though it is strange that when he did see it he does not seem to have compared his observations with the place assigned by Le Verrier for the planet. Dr. Hind, in his 'Solar System' (p. 138), suggests that Lamont's September observations were made "probably in consequence of a search commenced on the announcement of M. Le Verrier's remarkable results"; and this view is repeated by Mr. Chambers in his Handbook. Of course, though Lamont could not on Sept. 7 have seen Le Verrier's paper read on Aug. 31, he may have read the earlier one of June 1, which gives the planet's place less accurately, and only claims to give it within

10 degrees. But there is no appearance of his having done s the zones seem to have been observed in regular course, and to r I confess it is quite incredible that if he had been searching for t planet, he should not have compared his observations. It may said that neither did Challis till he heard of Galle's discovery; b then he was dealing with a much larger mass of observations th Lamont, besides which the latter never seems to have compar his at all, but left it for Dr. Hind to recognize the fact that he h observed the planet twice in September 1846, as well as once October 1845. I conclude, therefore, that Lamont's observatio of Neptune were as much fortuitous as those of Lalande, mc than fifty years previously. Yours faithfully,

Blackheath, 1895, June 2. W. T. Lynn.

---

## OBSERVATORIES.

**Royal Observatory, Greenwich.**—The Report of the Astr nomer Royal presented to the Board of Visitors on June 1 shov that the large increase in the number of observations made wi the Transit-Circle, mentioned in last year's Report, has be maintained during the past twelve months. The actual numb for the year ending 1895 May 10 are: Transits 11,240, Cir observations 11,006. The instrumental correction applied zenith-distance observations known as R – D, for 1894, + 0″·057 + 0″·546 sin z.d., which is rather smaller than t similar value for recent years. A series of experimental c servations is being made to obtain, if possible, further formation as to the cause of this correction. The colatitude the Transit-Circle as determined in 1894 is 38° 31′ 21″·96, wh is 0″·06 greater than the adopted value. The correction to tabular value of the Obliquity of the Ecliptic found fr observations in 1894 is +0″·18, and the correction to the Ri Ascensions of the clock-stars is +0ˢ·042.

The progress of the work on the Astrographic Chart is b indicated by the numbers of Fields successfully photograp during the year, which are for the Catalogue 180, for the Chart These figures bring the total numbers of Fields photograp since the beginning of the work to 422 for the Chart and 617 the Catalogue. The measurement and reduction of these pla has been systematically begun.

The 28-inch Refractor, which is now in regular use and reported as quite satisfactory, has been used for the measurem of double stars and of the dimensions of planetary systems, a also, in a lesser degree, for spectroscopic work; but as the n spectroscope now being made by Messrs. Troughton and Simm not yet completed, the work on this branch has been to so extent experimental. Observations of Comet *b* 1894 and Comet Encke have been made with the Sheepshanks Equator but, as need hardly be said, there has been an unusual scarcity of these visitors during the year.

The Report gives interesting meteorological information relating to the past year and the usual statement as to the work done in the chronometer and time-signal department. A second chronometer-room has lately been added to allow for the increase of this work.

The sun-spot record for 1894 shows that there was only a slight falling off the mean daily spotted area as compared with 1893; but in the spring of the current year a decline both in the number and area of the spots is quite apparent.

As to the extension of the buildings and equipment, which has been so marked a feature at the Royal Observatory of late years, the building of the Physical Observatory, of which the south wing is finished and in use, is progressing slowly, a fact which has caused some hindrance to the computing work. The New Altazimuth building is near completion, and the dome and the instrument will shortly be mounted. It is proposed to erect a small building in the park as a Magnetic Observatory, for the absolute determinations of the magnetic elements. The work on the new 26-inch photographic telescope, the gift of Sir Henry Thompson, is in the hands of Sir Howard Grubb, who is now working on both the glass discs, and, as has been said, Mr. Simms is making a new spectroscope, which will be used for photographing spectra.

---

UNIVERSITY OBSERVATORY, OXFORD.—The Report of Prof. Turner to the Board of Visitors exhibits the work done since 1894. June 9, and the actual state of the Observatory on 1895. May 25. We learn that, in common with other Institutions, the work suffered somewhat from the frost, and for three months the photographic plates had to be developed away from the Observatory. During the period covered by the Report 255 Catalogue plates, with exposures $6^m$, $3^m$, and 20 secs., were taken, making the total number up to 590 out of 1180 required. A specially designed micrometer has been in constant use for the measurement of the plates since 1894, October, the use of which has been found to be simple and rapid, and since the beginning of 1895, 40 plates, containing 11,734 stars, have been measured, which, added to the work done previously, give 46 plates, or 13,611 stars; an average of 296 stars per plate. No chart plates have been taken. It is, however, by no means the intention of Prof. Turner to neglect these, but the work of the Observatory has, during the last few years, been much broken up, and there have been many incidental things to attend to. Besides these catalogue plates some 12 photographs of the Pleiades have been measured at the request of Mr. H. F. Newall, to determine very exactly the distance of two selected stars suitable for finding the revolution of his micrometer screw. After many attempts to get satisfactory observations with the Barclay

Transit Circle, without success, it was sent to Messrs. Troughton and Simms, who found that at some time the circle had received serious injury. It is now ready for remounting. Dr. Common has presented a 12-inch plane silver-on-glass mirror, which Prof. Turner intends for use with a new form of transit circle, the work on which is in an advanced state.

It must not be forgotten that the Observatory has its educational side, and we note that the Director has been busy in devising and constructing an apparatus which shall represent the apparent rotation of the heavenly bodies about the Pole. For the framework, two bamboo rods, 15 feet long, are connected at one end to a pivot (representing the pole), and at the other to the ends of a toothed arc, 3 feet long, which is moved uniformly by clock-work to represent the daily motion of south stars. The arc carries a frame wherein are placed stellar photographs (positives), illuminated from behind by an incandescent gas-burner. The whole is mounted near the roof of the Lecture-room, and observed from the middle of the floor by a small transit circle. The instrument can either be used merely for practice in observing transits, for determining differences of personal equation—ultimately, it is hoped, for determining absolute personal equation,—or for practice in adjusting a transit by observations of stars near the pivot (Pole) and near the arc (Equatorial).

---

Bidston Observatory, Liverpool.—The Report of the Director of this Observatory, Mr. W. E. Plummer, for 1894, to the Committee of the Mersey Board, who look after the interests of this institution, shows a considerable amount of work done in proportion to the smallness of the staff. The work is to some extent of a routine character and largely utilitarian, as may be gathered from the fact that the determination of time for local time-signals and the rating of chronometers forms a large part of it. Mr. Plummer remarks that the weather in 1894 was not so favourable for observation as in the preceding year, but nevertheless time-determinations were made on 180 nights, which seems a satisfactory number, as on no occasion was it necessary to "carry on" the clock-rate for more than 5 days on account of failure of observations. The time distributed for signals is Greenwich Mean, and to find this the value of the longitude, $12^m\ 17^s\!\cdot\!33$ W. of Greenwich, found by Mr. Plummer in 1893 from a telegraphic determination, was used. A re-determination of the latitude of the observatory has also been made, the result of which is 53° 24′ 4″·8 N.

The Equatorial was used chiefly for observation of comets. Positions of Denning's Comet were found on 5 nights, and of Gale's on 25 nights. These observations have been communicated to the Royal Astronomical Society. Encke's Comet was also observed, but the results are not yet published.

No change was made in the meteorological instruments for methods during the year. The results of this branch are given in the Report. There is also, as an Appendix, a discussion of the diurnal inequality of barometric pressure, as deduced from observations in the years 1867–94. Curves are given for showing the mean diurnal variations of height of the barometer for each month, which it is interesting to study. The mean diurnal variation for the year is represented by the formula—

$$+0^{\text{in}}{\cdot}0020 \sin(\theta+63^\circ)+0^{\text{in}}{\cdot}0080 \sin(2\theta+138^\circ),$$

where $\theta$ represents the interval elapsed since midnight expressed in degrees. The coefficient of the first term of this is smaller than the similar quantity found from Greenwich observations ($0^{\text{in}}{\cdot}0029$), and from those at the Radcliffe Observatory ($0^{\text{in}}{\cdot}0034$). Mr. Plummer remarks on this point that the monthly curves differ so much among themselves during the year that the yearly mean probably has little value except for comparison with other observatories.

## PUBLICATIONS.

BULLETIN BY THE PERMANENT COMMITTEE OF THE ASTROGRAPHIC CHART. Vol. II. part 3.—This part, recently published, contains, as is usual, reports of the work done at the various co-operating observatories, which, if we neglect details relating to individual establishments, may be sufficiently summarized by quoting extracts from M. Tisserand's introductory note, where he gives a short report on the actual present state of the whole undertaking:—

"One may say that by next spring at least twelve of the eighteen observatories will have completed the number of plates for the *Catalogue* assigned to them. Three or four have already done so; others will as quickly as possible make up the time lost owing to conflicting circumstances. This is an important result, and we may congratulate ourselves that an international work of some magnitude will have been brought to a successful termination with instruments and methods nearly identical.

"The Chart is less advanced than the Catalogue. At the observatories where most has been done, not more than a third of the allotted task is completed. It can easily be understood that efforts are first directed to the Catalogue plates; the long exposures for the Chart are more troublesome, and on many evenings the uncertain state of the sky makes the exposure of a plate inadvisable."

M. Tisserand thinks that for several reasons it would be well, as Dr. Gill has suggested, to have a meeting of the Committee at Paris next year. Some points calling for discussion are: (1) the method of reduction of the plates, and the limit of accuracy to be striven for in the measures and reductions; (2) the determination of the photographic magnitudes of the stars; and (3) the reproduction on paper of the Chart plates. It certainly seems to us

that the time has come for another meeting, for the directors
observatories and other members of the Committee, having n
had much practical experience, are more competent to discu
methods and pass resolutions for the conduct of the work th
they were at the time of the earlier meetings.

This fascicule contains four memoirs, three of which relate
the measurement of the positions of stars on the plates. The fir
by Prof. Turner, gives with rigorous formulæ his method of r
duction, which has already been explained in these pages (Vol. x
p. 373). The second is a continuation of M. Prosper Henr
memoir begun in the preceding part of the 'Bulletin,' whi
gives some examples of his method of reduction of measure
M. Donner supplies a paper on the constants of the measuri
apparatus and the errors of the lines of the réseau in use
Helsingfors.

The fourth is an exhaustive memoir by M. Trepied on the subje
of the magnitudes of the stars photographed. An obviously i
portant purpose to which the plates of the chart could be appli
would be to investigate the distribution of stars in the sky
cording to brightness. M. Trepied very properly remarks that su
a research would require (1) a precise definition of *photograp*
magnitude; (2) the establishment of a scale of photographic magn
tudes common to all the observatories; and (3) the determinati
according to this scale, of the photographic magnitudes of all t
stars contained on the plates; and he proceeds to satisfy the t
first of these wants, and suggests a means of expeditiously su
plying the third.

Clearly, if all stars of the same visual brightness were
recorded on the plates by images of the same diameter, the phot
graphic scale might be a scale of diameters, which would represe
magnitudes corresponding to the visual. But inspection of t
plates shows that stars of the same magnitude do not appe
always as having equal diameters, nor is the same star represent
on different photographs by images of equal size, owing to d
ference of atmospheric causes, of zenith-distance, and of sensibil
of plates. This last may, however, be minimized in any inves
gation by the application of corrections to the measured diamet
to reduce them to what they would have been if the photogra
had been taken under ideal circumstances. M. Trepied has co
ducted his researches on these lines, and has evolved a scale
corrections to convert measured diameter to the diameter of t
same star if photographed on an ideal evening (*soirée-type*), and t
being done, the photographic magnitude taken as correspondi
to any reduced diameter is the arithmetical mean of the visu
magnitudes of all stars which have this diameter.

We do not propose to follow M. Trepied through the details
his elaborate research; suffice it to say that photographs we
taken, each on three evenings, of each of the seven regions whi
were selected as specimen areas by Prof. Kapteyn, the magn

tudes of the stars in which were determined by the late Prof. Pritchard. The diameters of the stars on these photographs were measured, and the mean conditions, so to speak, of these photographs were taken as a *soirée-type*, to which all the measured diameters were reduced. By comparison, then, of these reduced diameters with the magnitudes as determined by Prof. Pritchard, a scale of photographic magnitude has been formed.

The final formula connecting the measured diameter with the magnitude is of the form $m=a-b \log \Delta$, where $m$ and $\Delta$ are respectively magnitude and diameter and $a$ and $b$ are quantities depending on the circumstances of the photograph. The method of applying this formula in practice is this:—On a night when photographs are taken a photograph of one of these selected typical areas must also be taken. The comparison of the measured diameters of the stars on this area with the theoretical diameters of the same stars on a standard evening will give values of $a$ and $b$ for the evening under discussion; and these values being substituted, the above-quoted formula will readily give the magnitude of a star whose diameter has been measured.

M. Trepied proceeds to discuss methods for supplying the third want—the measurement of the photographic magnitude of all the stars. He proposes as an expeditious plan that a photographic representation of stars of different magnitudes, as seen in the micrometer of the measuring instrument, should be made and affixed to the measuring machine, and that the person measuring the positions of the stars could at the same time easily estimate and record the diameters. He thinks that this method would be at least as precise as the method of estimating visual magnitudes.

In his introduction M. Tisserand pays graceful tribute to the memory of Prof. Pritchard, referring specially to the service he afforded the enterprise by his photometric work on the typical areas, and also to the memory of Father Denza, Director of the Vatican Observatory, who died in December last.

---

## NOTES.

Comet Notes.—M. Bigourdan investigates in 'Comptes Rendus,' No. 18, the orbit of the comet of 1771, which has hitherto been regarded as having a strongly hyperbolic orbit ($e=1\cdot009$). This, however, mainly depended on the latest observation of the comet which was made at Marseilles on July 17. M. Bigourdan has found the original manuscript of the Marseilles observations at the Paris Observatory, and has detected an error of 10 seconds in the reduction of the R.A. on the above day. Making this correction, the orbit appears to be an ellipse ($e=0\cdot998$).

The 'Bulletin Astronomique' for June contains definitive elements of Comet 1892 V. (Barnard) by M. Coniel. Prof. Porter had previously published elements from observations extending from Oct. 13 to Nov. 21, and these are used in the formation of an ephemeris for comparison with the observations in the present investigation. There is, however, an additional observation available made at Nice on Dec. 8. The following are the final most probable elements and the probable errors of each:—

| | Epoch 1892 Oct. 22·5 Paris M.T. | | Probable Error. |
|---|---|---|---|
| M ...... | 352° 34′ 0″ | | 25′ |
| φ ........ | 36 8 4 | | 49′ |
| π ........ | 16 31 28 | 1892·0. | 30′ |
| ☊ ...... | 206 30 57 | | 11′ |
| $i$ ........ | 31 16 19 | | 5½′ |
| μ ........ | 544″·099 | | 25″ |
| log $a$ .... | 0·54289 | | 0·0130 |
| Period.... | $6^{\mathrm{y}}{\cdot}52$ | | $0^{\mathrm{y}}{\cdot}31$ |

If the period should be as great as $6^{\mathrm{y}}{\cdot}65$, the comet may be seen at its next return in 1899, but otherwise not before 1905 or even 1911.

M. Couiel discusses the question of the former identity of this comet with that of Wolf, the conclusion being that this identity is highly probable, but the date of the separation he places in 1816, or even earlier; perturbations by both Jupiter and Mars are required to account for the modification of their orbits. The period is more likely to fall below than above 6·52 years.

Dr. Bredichin has just published a discussion of the movement of the substances emitted by the Comets 1893 IV. and 1893 II., based on the photographs of Profs. Barnard and Hussey respectively ('Bulletin of the Imperial Academy of Sciences, St. Petersburg, 1895 May). In the former case the photographs indicate (1) that the cone of emission of the matter projected from the nucleus made oscillations round the radius vector; and (2) that this matter was not uniformly projected, but in jets of different duration and different density, which is further confirmed by the existence of several detached masses of nebulous matter. An examination of the position of these masses on consecutive days affords a measure of the rapidity with which the matter of the tail is projected from the nucleus. Dr. Bredichin divides tails into two types. The first he supposes to be due to hydrogen; the main tail of the Comet 1893 IV. was of this type, though it occasionally showed jets of the second type. The second type is that of 1893 II., in which the rate of projection from the nucleus was determined to be 400,000 miles per hour from the photographs of Prof. Hussey. Dr. Bredichin deduces that the molecular weight of this substance is $\frac{1}{14}$ of that of hydrogen, and conjectures that it is identical with the material forming the streamers of the Solar Corona.

There is another article on Comet 1893 II. in 'Popular Astronomy' for June, by Prof. Hussey. This is accompanied by a reproduction of a beautiful photograph of the comet taken at the

Lick Observatory, 1893 July 13. This shows very clearly the detached masses of matter in the tail alluded to above. By the comparison of two photographs taken on the same day, three of these masses were shown to be receding from the nucleus at rates of 45, 53, and 60 miles per second respectively. They must therefore have moved very considerably during the exposure of the plates (70 minutes), and this must be allowed for in the interpretation of the photographs. Prof. Hussey comments on the great increase in our knowledge of the structure of comets' tails which photography has brought about, and contrasts the complicated forms thus revealed with the symmetrical curved hollow cone shown in the drawings of the tails of so many comets previously to the application of photography.

The same number of 'Popular Astronomy' describes a search made by Mr. William Brooks for the periodical Comet 1889 V. (Brooks), of which we recently gave a search ephemeris by Prof. Charles Lane Poor. The comet was sought both visually and photographically, the sky being quite clear, but without success. It will, however, be much more favourably placed next year.

The Damoiseau Prize of the French Academy of Sciences for 1896 is offered for the best dissertation on the orbit of Halley's Comet, with a view to the prediction of the circumstances of the next return in 1910.

Mr. David E. Packer contributes a letter to the 'Journal of the British Astronomical Association,' giving some evidence for the existence of an eleven-year period of comet frequency (telescopic comets being excluded from the research). He associates this period with that of sun-spot activity. It is, however, very difficult to conceive that the supposed periodicity of cometary apparitions can be other than a chance coincidence, when one considers the entire independence to one another of the orbits of different comets, and the fact that planetary perturbations may alter their periods by years, or, in many cases, even by centuries. Thus, even if such a relation existed at any one time, it would be an eminently unstable one, whose permanent maintenance appears to be impossible.

A. C. D. C.

---

MINOR PLANET NOTES.—Dr. Berberich announces that the planet BX, discovered by Charlois on May 18, is probably identical with (156) Xanthippe, which has been missing since 1875, the year of its discovery. Should this identity be confirmed, it reduces the number of missing planets (discovered previously to 1890) to eight only.

One of these is (132) Aethra, discovered in 1873 and observed from June 13 to July 5 in that year, which has never been seen since. Its re-discovery is greatly to be desired, on account of its small perihelion distance. Dr. Luther gives a search ephemeris for the present year in Ast. Nach. 3292, which we give below (abridged):—

| 1895. | R.A. h m | N. Dec. ° |
|---|---|---|
| Aug. 1.... | 1 51 | 36·3 |
| 13.. | 1 57 | 37·9 |
| 25.... | 2 0 | 39·3 |
| Sept. 6.... | 2 0 | 40·4 |
| 18.... | 1 55 | 41·1 |
| 30.... | 1 47 | 41·2 |
| Oct. 12.... | 1 35 | 40·6 |
| Oct. 24.... | 1 22 | 39·0 |
| Nov. 5.... | 1 10 | 36·7 |
| 17. .. | 1 1 | 33·9 |
| 29.... | 0 56 | 31·0 |
| Dec. 11.... | 0 56 | 28·2 |
| 23.... | 1 0 | 25·9 |

The magnitude at opposition is about 11. It is to be hoped that the possessors of large instruments will take part in the search either photographically or visually. It should extend $20^m$ in R.A. and nearly 1° in Dec. on each side of the ephemeris place.

The following planets have received permanent numbers;—

| Planet. | Date of Discovery. | Discoverer. | No. |
|---|---|---|---|
| BE... | 1894 Nov. 1 | Wolf. | 391 |
| BF... | Nov. 4 | „ | 392 |
| BG... | Nov. 4 | „ | 393 |
| BH... | Nov. 19 | Borrelly. | 394 |
| BK... | Nov. 30 | Charlois. | 395 |
| BL... | Dec. 1 | „ | 396 |
| BM... | 1894 Dec. 19 | Charlois. | 397 |
| BN... | Dec. 28 | „ | 398 |
| BP... | 1895 Feb. 23 | Wolf. | 399 |
| BU... | Mar. 15 | Charlois. | 400 |
| BT... | Mar. 16 | Wolf. | 401 |

BD, BO, BQ have not been sufficiently observed to receive permanent numbers; while BJ, BR, BS, BV were found to be identical with the planets 369, 379, 333, 203 respectively.

401 has been named Ottilia, and 369, discovered by Borrelly 1893 July 4, has been named Aëria.

A. C. D. C.

---

Observation of Jupiter's Satellites.—Appropriately enough, remembering Mr. Marth's remarks at the last R. A. S. meeting, there has come to hand recently a paper, by M. Landerer, on th subject of Jupiter's satellites. This is a new edition in Frenc of a work published in 1892, which gives tables for readily computing the latitude and radius vector of any of the satellite the only argument required being the date. The object o these tables is naturally to assist computers who compare theor with the results of observation, and the author calls attentio to some corrections to data that he has evolved ('Compte Rendus,' vols. cxiv. & cxviii.). He points out that observation of the third satellite in 1899, or better still in 1905, will b especially useful for determining the correction to the longitu of satellite III.

M. Landerer is of opinion that observations of transits of t shadows across the disc are preferable to the observation eclipses, because the difficulty of finding the instant when t *centre of the shadow* is on the edge of the disc is not so great as that of finding when in an eclipse the *centre of the satellite* is at the edge of the shadow. He gives a geometrical investigation of the question of finding the desired instant in the case of the transit of a shadow from the observed times of interior and exterior contact. Referring to the long time that sometimes elapses between these two last-mentioned phenomena, an observation by M. Flammarion is quoted, when the shadow occupied twenty-six minutes in crossing the limb. The value of this interval computed by M. Landerer's formula for this occasion would be twenty-two minutes, which may be considered a satisfactory agreement, remembering that accidental circumstances of observations are not taken into account by the formula.

---

THE measures of the diameters of Jupiter's Satellites referred to by Mr. Lewis at the R. A. S. meeting reported in this number are :—

Means of Equatorial and Polar diameters as observed at

| | I. | II. | III. | IV. |
|---|---|---|---|---|
| Chicago...... | 1″·114 | 0″·980 | 1·778 | 1·457 |
| Lick ........ | 1 ·048 | 0 ·870 | 1·521 | 1·430 |
| Greenwich .. | 1 ·084 | 0 ·959 | 1·454 | 1·350 |

The measures of the equatorial and polar diameters respectively as observed at Greenwich are :—

| | I. | II. | III. | IV. |
|---|---|---|---|---|
| Equatorial .... | 1·052 | 0·921 | 1·449 | 1·354 |
| Polar ........ | 1·115 | 0·997 | 1·458 | 1·347 |

---

DR. SEE has re-determined the orbits of OΣ 535 (δ Equulei) and of Σ 3062, and finds elements differing very little from the previous determinations. This is very satisfactory, and we may consider the periods 11·45 years and 104·61 years respectively as very near the truth.

Σ 3062 is a fairly easy object ($a = 1''\cdot37$); but δ Equulei is more difficult ($a = 0''\cdot45$), and as it is one of the most rapid binaries known, if not the most rapid, it is "worthy of special attention from observers who have large telescopes." Dr. See gives for ephemeris

| *t.* | *θ* | h |
|---|---|---|
| 1895·5 | 247°·0 | 0·12 |
| 1896·5 | 215 ·2 | 0·31 |
| 1897·5 | 207 ·2 | 0·47 |

---

A NOTE, which may be regarded as an addendum to Mr. Stone's comparison of the Radcliffe Catalogue 1890 with others (M. N. R. A. S. 1895 March), is published in Ast. Nach. 3287. Mr. J. G. Porter, of the Cincinnatti Observatory, has caused a comparison to be made of the Cincinnatti Catalogue 1890 with the Radcliffe 1890, with the results as given below :—

Arranging the stars in R.A.:

| | $\Delta\alpha \sin \delta$. | $\Delta\delta$. |
|---|---|---|
| $0^h$ to $6^h$ | $+0^s{\cdot}051$ | $+0''{\cdot}41$ |
| 6 „ 12 | $+0{\cdot}093$ | $+0{\cdot}91$ |
| 12 „ 18 | $+0{\cdot}070$ | $+1{\cdot}06$ |
| 18 „ 0 | $+0{\cdot}083$ | $+0{\cdot}48$ |

In order of N.P.D.:

| | $\Delta\alpha$. | $\Delta\delta$. |
|---|---|---|
| 70° to 80° | $-0{\cdot}037$ | $+0''{\cdot}54$ |
| 80 „ 90 | $+0{\cdot}002$ | $+0{\cdot}96$ |
| 90 „ 100 | $+0{\cdot}058$ | $+0{\cdot}74$ |
| 100 „ 110 | $+0{\cdot}107$ | $+0{\cdot}71$ |
| 110 „ 120 | $+0{\cdot}129$ | $+0{\cdot}72$ |

$\Delta\delta$ represents the difference of N.P.D., and the differences in all cases are taken in the sense Cincinatti—Radcliffe.

The places of the Cincinatti Catalogue in both elements depend on the system of the *Berliner Jahrbuch.* The Right Ascensions of the Radcliffe on Greenwich clock-star lists. The differences of N.P.D. are comparable in magnitude and in sign, so far as the Radcliffe Catalogue is concerned, with those found by Mr. Stone's comparison mentioned above.

---

A CORRESPONDENT writes:—"In reference to the quotation from the Bishop of Salisbury respecting Dante's astronomy, in the 'Observatory' for June, I write to say that Longfellow, in his notes to Dante, quotes from Dr. Barlow, who thinks that Dante referred to the first inhabitants of Europe and Asia, and not to Adam and Eve.

"Dr. Barlow quotes a passage from Humboldt's 'Cosmos,' which speaks of the Southern Cross being visible in northern latitudes:—

"'It began to become invisible in latitude 52° 30′ N. 2900 years before our era, since, according to Galle, it might previously have reached an altitude of 10°. When it disappeared from the horizon of the countries of the Baltic, the Great Pyramid had already been erected more than 500 years.'—*Cosmos*, 2.

"Longfellow states the three stars of Canto 8 to be those which the Bishop names 'the Alpha of Eridanus, of the Ship, and of the Golden Fish.'

"From the Hon. W. W. Vernon's 'Readings on the Purgatories' I quote the following:—'Philalethes says that Dante may have heard of the existence of the Southern Cross from Marco Polo, who in 1295 was in Venice after his return from his voyage, which he had pushed as far as Java and Madagascar.'"

---

THE Publishers of 'Knowledge' ask us to announce that Dr. Isaac Roberts, F.R.S., has kindly offered to continue in that periodical his exquisite selection of Photographs of Stars, Star-Clusters, and Nebulæ, and the first photograph will appear very shortly. The series is intended to be in continuation of Dr. Roberts' work—'A Selection of Photographs of Stars, Star-Clusters, and Nebulæ'—recently published, and which has, admissibly, contributed largely to the extension of the knowledge of astronomical phenomena.

We have received from Mr. C. Leeson Prince, of Crowborough, "A record of the great frost of January and February 1895, contrasted with some observations of other severe frosts," which gives, besides the temperature records of last winter, complete and interesting details of the temperature of every winter since 1816—those from the year 1843 being Mr. Prince's own records made at Crowborough or in its neighbourhood. It appears that the recent frost was the most protracted since that of 1814.

It may not be out of place to put on record here, that the Shahzada has not visited Greenwich Observatory. It was proposed that he should do so, and arrangements were made for his reception on June 7; but circumstances willed otherwise, and he did not get nearer than the Park gates. Nevertheless, most of the daily papers informed their readers next morning that he had been shown over the Observatory by the Astronomer Royal, and had been much impressed by what he saw.

It will probably have occurred to Fellows who attend the meetings of the Royal Astronomical Society that the attendance during the Session just closed has been considerably larger than in former years. The book in which some persons who attend write their names is not a very accurate record, but we have reason to know that the entries bear out the fact to some extent.

Dr. O. Backlund has been appointed Director of the Poulkova Observatory, in succession to Dr. T. Bredichin, whose resignation we announced in our February number.

The Paris Academy of Sciences have elected Dr. Backlund Corresponding Member in the section of Astronomy, to fill the vacancy caused by the death of Dr. R. Wolf.

Mr. S. S. Hough, of St. John's College, has been elected to the Isaac Newton Studentship of Astronomy in the University of Cambridge for three years ending June 15, 1898.

Mr. Charles Chree, Director of the Kew Observatory, is to be created Doctor of Science of Cambridge.

---

## From an Oxford Note-Book.

I should like to draw the attention of those who might by chance overlook it, to the Memoir of Lewis Morris Rutherfurd, which Dr. B. A. Gould has just read before the National Academy of Sciences. Dr. Gould has been hard at work on the memoir for more than two years, and though there is a note of despair in the preface, those who trust the reputation of the writer even against his own judgment will not be disappointed in the achievement. It cannot be too often or too emphatically recalled what Rutherfurd did in stellar photography and spectroscopy, and I make no apology for quoting the following remark made in 1865 (Am. J. of Sc. xxxix. p. 308):—

"The power to obtain images of the 9th magnitude stars with so moderate an aperture (11¼ inches) promises to develop and increase the application of photography to the mapping of the sidereal heavens and in some measure to realize the hopes which have so long been deferred and disappointed. It would not be difficult to arrange a camera-box capable of exposing a surface sufficient to obtain a map of 2° square, and with instruments of larger aperture we may hope to reach much smaller stars than I have yet taken. There is also every probability that the chemistry of photography will be very much improved and more sensitive methods devised."

We are now engaged in the mapping of the heavens in portions 2° square as Rutherfurd foretold 30 years ago; and the chemical improvements which he foresaw have obviated the necessity of a much larger aperture.

---

But concerning these same star-maps, a danger which was hinted at in these Notes some time ago seems to be a very real one—that of the disappearance of the smaller images from the photographic film in course of years. Dr. Roberts writes to me:—

"Since writing to you I have examined some of the stellar negatives which I took in February 1886, in March 1886, and in March 1887. Each of these negatives covers fully 2° × 2° of the sky with the centre in R.A. $9^h\ 40^m$ and declination north 72°; the exposure of the first and second was during 15 minutes each, and of the third 60 minutes. Within a month of the taking of these plates I counted, by aid of a microscope, all the stars, from the brightest down to the faintest, visible on the films, and a week ago (May–June, 1895) I again counted the stars under conditions similar to those of 1886–87; following are the results:—

"On the plate 1886 Feb., 403 star-images were counted, but on the same plate in 1895 June 272 star-images could be counted, thus showing the total disappearance of 131 star-images from the film in the period of 9¼ years.

"On the plate 1886 March, 364 star-images could be counted, but on the same plate in June 1895 only 234, thus showing the disappearance of 130 star-images in 9¼ years.

"On the plate 1887 March, 403 star-images were counted, but on the same plate in 1895 June only 344, thus showing that 59 star-images had disappeared in about 8 years.

"The negatives have always been kept in grooved boxes in dry rooms, and seldom exposed to light, but the films have not been varnished. The gelatine-bromide plates were obtained from the well-known makers of the most sensitive plates in those days, and the films do not indicate deterioration, unless it be a slightly yellower tint, which I suspect. The plates are developed with pyro and ammonia.

"These facts are without reserve at your disposal, and I do not intend myself to make any use of them."

---

Our deep sympathies are with Sir Robert Ball, who has lost his younger brother, Dr. Valentine Ball, C.B., F.R.S., the distinguished Director of the Irish National Museum in Dublin. Starting life in the Geological Survey of India, Mr. Valentine Ball extended his researches in the directions of zoology and anthropology; and his miscellaneous but sound knowledge fitted him for the directorship of a great Museum in an exceptional degree. He succeeded the Rev. Dr. Haughton in the Chair of Geology at Dublin in 1881, and Dr. Steele as Director of the National Museum in 1883, resigning the Chair of Geology in order to take this position, which was so admirably suited to his tastes and capacities. He died somewhat suddenly on June 15 last.

---

I am indebted to Major R. A. Murdoch, R.A., Assistant Superintendent of Records at Woolwich, for the following interesting extract from the Records:—

"Ordnance Warrant. 16 Sep. 1675.

*Present*
Master General of the Ord$^{ce}$
Surveyor
Clarke Ordnance
Storekeeper.

"Ordered that y$^e$ one third part of y$^e$ ould unserviceable gunpowder now in his Majestie's stores, y$^e$ whole in y$^e$ Tower being 573 barr$^l$ 80 lb stoweable: 55 barr. 10 lb reparable: 45 Barr. 90 lb nett. and 654 Barr. more unserviceable now returned from Portsmouth, be forthwith issued and dd. to Mr. Polycarpus Wharton, he paying for y$^e$ same into y$^e$ Treasury of y$^e$ said office of his Maj$^{ties}$ Ordnance after y$^e$ value of ——p barrell ready mony 500 lb of y$^e$ monyes to be applyed and made use of according to his Ma$^{ties}$ law warrant for building an house for an Observatory at Greenwich."

If cordite is found to be a great success after all, this precedent might perhaps be used to get astronomical funds from the sale of the old gunpowder? The Astronomer Royal should be interested in Mr. Campbell Bannerman's successor.

---

The Astrological Note last month brought me a welcome and interesting letter from General Tennant. "The first Lord Lytton was a man who had a queer collection of strange knowledge, and possibly he got some information as to the astrological meaning of Herschel from an out-of-the-way book. Anyhow, in 'What will he do with it?' he makes Merle the Cobbler say (Chap. XIX.):—

" 'What the plague did the 'Stronomers discover Her for? You see, Sir, things odd and strange all come alo Herschell. He's an awful Star for females! hates them poison. You see Herschell, though he be a sinister chap specially in affairs connected with 'other sex, disposes the N to dive into the mysteries of Nature.' "

I am also informed by another correspondent that Hersche Neptune were studied by astrologers from the date of thei covery, but less is known of their attributions than of those pl which were known to the old astrologers. " The attributio Neptune are still being investigated by my astrologer as w by others, though there are some who aver that Neptune h influence upon our destinies, on the ground that it belon another solar system."

---

*A PROPOS* of the examination vagaries noticed last mon correspondent kindly sends me the following specimen questions set some 20 years ago to a class of schoolboys :—

1. Explain the following passage, and illustrate from Hesiod and Virg

   ἀτὲρ γνώμης τὸ πᾶν  
   ἔπρασσον ἔστε δή σφιν ἀνατολὰς ἐγὼ  
   ἄστρων ἔδειξα τάς τε δυσκρίτους δύσεις.

2. Explain with figures the theories of eccentric and epicyclic motion.
3. Show how the Sun's action tends to alter the Moon's orbit, and e fully the inequality called the evection.

The chief interest of these lies in the comments made by S B. Airy on them. " One of the things which strikes me," he " is that the examination is too high. There is much wh could not answer. I should like to know how far your pupi into the first practical points for which reading is scarcely n sary. Do they know that the stars rise and set? Very people in England know it. I once had a correspondence w literary man of the highest rank on a point of Greek astronomy found that he did not know it." It is not quite clear whether noticed that the very first question was about this rising and set

---

ARE there any astronomers, in these days, interested in G verses? I fear I cannot offer any personal testimony of val to the merit of the following; but they are taken from 'Se Carthusianum' (p. 115), and signed " Richard Claverhouse Jebb

πολυπλάνων δ' ἔφραζε συμπεπλεγμένας  
ἄστρων κελεύθους στροφάδας, ἥλιόν θ', ὅθεν  
τίν' ἔρχεται κευθμῶνα, καὶ μήνης κύκλον,  
ποίαις ἐπῳδαῖς ὠχριᾷ κηλούμενος  
πελάγους ἀναυγήτοισιν ἐν μεταλλαγαῖς;

being a translation of a passage in Shelley's 'Prometheus Unbo (Act II. scene 4):

He taught the implicated orbits woven  
Of the wide-wandering stars; and how the Sun  
Changes his lair; and by what secret spell  
The pale Moon is transformed, when her broad eye  
Gazes not on the interlunar sea.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

No. 230. AUGUST. 1895.

### THE BRITISH ASTRONOMICAL ASSOCIATION.

The last meeting of the fifth Session was held at University College, Gower Street, on Wednesday, June 26, the President, Mr. E. Walter Maunder, in the Chair.

The election of two new members was confirmed by the meeting, and the names of seven candidates for membership were suspended.

Among the presents announced were three memoirs containing observations of Mars in 1877, 1879, and 1881–2 by Prof. Schiaparelli. In the letter accompanying the volumes Prof. Schiaparelli requested to be furnished with the programme of the observations of Mars for 1896, and hoped to be able to contribute to the work of the Section.

A letter from *Mr. Waugh*, Director of the Jupiter Section, was read, drawing the attention of the Members of the Section to a suggestion of Captain Noble as to the possible cyclical movements of the Jovian markings, and asking their co-operation in the collection of data for the discussion of the question.

*Mr. Henry Corder* read a paper on "The Growth and Decay of Sun-spots." He said that he had been continually impressed during the whole of the recent sun-spot maximum with the fact that the spots seemed to die away as they neared the western limb. Almost without exception the larger groups were at their greatest activity between the eastern limb and the centre of the disc, and had in many cases broken out near the eastern limb, reaching their maximum near the centre. He thought this phenomenon was worthy of fuller investigation during the next maximum, because if the growth and decay of sun-spots were really influenced by the position of the Earth, it should always recur.

A note by *Miss Brown* on the subject was read, in which she said that her own observations led her to the conclusion that, although undoubtedly frequent, the phenomenon was by no means a constant occurrence, and it would be very unsafe to foun theory on mere general impressions. Great allowance must made for the effect of foreshortening, and there was the bability that a large percentage of spots originated on the sid the Sun turned from the Earth, which would naturally cause increased number of larger spots to the east of the centre.

*Col. Burton-Brown* suggested that probably observations m from another planet might give a very different view of the mat He asked Mr. Corder whether he could offer any explanatio the cause of the phenomenon.

*Mr. Corder* said he had merely recorded his own observati and he was anxious to learn whether they were confirmed by ot observers. He had no theory on the matter. Personally he fo it difficult to believe that the Earth had any influence in direction.

*The President* said that his own observations at Greenwich f confirmed what Mr. Corder had said. Very early in his w in the measurement of sun-spots he had been struck with number of groups that began as very small groups at the east li and increased in size until they reached the centre of the d and then diminished so as to disappear, or almost disappear, bef reaching the western limb. The natural suggestion of course that this was simply due to foreshortening, that the correcti for foreshortening were in error. He did not, however, th that this explanation would hold good. There was only one to settle the question, and that was to take the entire mas sun-spots over a number of years, sum them up, and see what of evidence the entire solar record gave. If they found as result any evidence of the influence of the Earth on sun-sp they would naturally conclude that the planets Venus and Jupite Venus on account of its nearness, and Jupiter on account its mass—would have a still greater effect, and the next th would be to examine the sun-spot records with regard to the p tions of Venus and Jupiter, but it would be perfectly fair ignore the influence of these two planets in the first inquiry.

*Mr. S. A. Saunders* sent a paper on "How to Determine Time with a Small Equatorial," in which he claimed that the t might be obtained to the nearest second by a small, well-mou equatorial.

*Mr. G. M. Seabroke* said Mr. Saunders was right as to the but the main difficulty was that there was usually, as far as experience went, no means of making the necessary adjustme with small instruments.

*The President* said that they had with them that evening on their most valued members, Mr. Marth; the meeting would with doubt like to hear some remarks from him.

*Mr. Marth* delivered a short address, in the course of which impressed upon the members the importance of always giv with every drawing or photograph the exact time at which observation was made—hours, minutes, and seconds, and the place of the observers. Photographs were absolutely useless for his purpose without them. Mr. Marth also referred to some interesting planetary conjunctions that had lately occurred. One, a transit of Venus over the Sun's disc as visible from the satellites of Saturn, and another a transit of the Earth and Moon visible from the satellites of Jupiter.

*Mr. J. Bartlett* contributed a note on the change of meaning in the words astrologer and astronomer, the modern meanings being the converse of those of ancient times.

*Mr. J. A. Holland, R.N.R.*, sent a note on a fireball observed at sea, and *Mr. A. R. Schutz* contributed a paper on "The Encouragement of a Popular Interest in Astronomy."

*The President* said that they had received a very lengthy paper from *Mr. David Packer* on "A Remarkable Relation between Comets and the Solar Variation," with an illustrative diagram which was before them. The paper was too long to be read, but the object was to trace a connection between cometary appearances and sun-spot maxima. The President, while complimenting the writer on the amount of labour and research devoted to the paper, thought that he had failed to establish his theory. The data seemed too vague and incomplete to be of much value.

A photograph of the spectrum of Saturn taken with the spectroscope of the Allegheny Observatory, presented by *Prof. J. E. Keeler*, was exhibited.

After some routine business the Session was closed and the Meeting adjourned until the last Wednesday in next October.

---

## *Adams's Determination of the Masses of Jupiter's Satellites.*

In the 'Observatory' of July it is reported that, at the Meeting of the Royal Astronomical Society, Mr. Marth revived a question which he put for the first time some years ago, relative to the work of Adams on Jupiter's satellites. As the question is one which can only be settled by inspection of the MSS., I regret that I have remained so long ignorant that it was raised.

Damoiseau's Tables are based upon elements, some of which he had himself deduced from a reduction of the observations; nevertheless he retains others—among them the values of the masses—which rest upon data derived by Delambre. The two are necessarily inconsistent, and in 1875, Adams, who was then engaged upon a revision of Damoiseau's Tables with a view to their continuation, determined the following values as consistent with data of the Introduction, for the masses and for Jupiter's compression:—

| Adams's values. | Damoiseau, Introduction, p. ii. |
|---|---|
| $m = 0{\cdot}0000283113$ | $m = 0{\cdot}0000168770$ |
| $m' = 0{\cdot}0000232355$ | $m' = 0{\cdot}00002322696$ |
| $m'' = 0{\cdot}0000812453$ | $m'' = 0{\cdot}0000884370$ |
| $m''' = 0{\cdot}0000214880$ | $m''' = 0{\cdot}0000424751$ |
| $\rho - \frac{1}{2}\phi = 0{\cdot}0216623$ | Compression $= \dfrac{1}{13{\cdot}492}$. |

The method by which Adams arrives at these numbers is the [illegible] method of the 'Mécanique Céleste,' except that it is unnecessary to follow Laplace through the laborious determination of $h : h'''$ &c. the ratios of the eccentricities relative to the perijove of IV.; for the absolute values of the quantities $h$ may be deduced from the coefficients of the proper terms in Damoiseau's Introduction, *e. g.* the two terms in the longitude of III.,

$$-2h'' \sin (u_3 - \varpi_4) - \frac{15}{4}\frac{M}{n''} h'' \sin (u_3 - 2u_0 + \varpi_4),$$

condense at conjunction into the single term (p. viii),

$$-1^{\text{m}}\ 5^{\text{s}}{\cdot}073 \sin (u_3 - \varpi_4)\,;$$

and thus give $h''$. Thence we find

$$h'' : h''' = 0{\cdot}045394.$$

Delambre's coefficient is $-1^{\text{m}}\ 56^{\text{s}}{\cdot}76$, and Laplace's value, which depends upon this, is

$$h'' : h''' = 0{\cdot}0816578.$$

This is the only substantial discrepancy between the numbers employed, and without doubt the difference in the results attained is mainly due to it.

In like manner, though less simply, the ratios of the quantities are found. These being determined, we do not require all the equations which a complete application of Laplace's method would demand. Besides the equation which gives $m'$, Adams makes selection of Laplace's (1) (2) (5) (6) in Chapter IX., the solution of which yields the above results.

Of most importance is the question whether Adams had scrutinised Damoiseau's coefficient $-65^{\text{s}}{\cdot}073$ by comparison with the observations, and had given it the weight of his judgment. He had not; nor, so far as I am aware, did he ever contemplate any such work. His anticipation in 1877—"that new Tables Jupiter's Satellites, founded on more accurate elements than those employed by Damoiseau, would appear before it became necessary to make the computations for the Nautical Almanacs of subsequent* years"—was not founded upon any preparations of his own for that end.

There is no reason to suppose that Adams attached any weight to the above determinations of the masses, seeing that he never published the values directly; the MS. appears to be little more than a study such as he was in the habit of making upon any work that he was examining, in order to test by cross verifications the accuracy and consistency of the whole; and recollecting the inconsistencies that remain in Damoiseau's elements, we cannot have any confidence that if, for example, Adams had selected Laplace's (3) or (4) in place of (5), the burden of the change in the masses would still have fallen so predominantly upon $m'''$.

---

* Subsequent to 1890.

Considerable expectations have been built upon the fact that Adams was engaged more or less closely for some years upon the theory of Jupiter's satellites. It will be well to say at once that the chief fruit of his attention was published in the 'Nautical Almanac' of 1880; this, like all the rest of his published work, was the result of exhaustive labour, quite out of relation to the unpretentious form in which the outcome was presented, and only discoverable by searching tests. The lectures are indeed valuable, but they are designed rather as an introduction to the theory than as an extension of it; moreover, they are incomplete, and leave out of view some of the most characteristic and difficult features.

Newcastle-on-Tyne, 1895, July 17. R. A. SAMPSON.

---

## *On the Duplicity of the Solar Line* $D_3$.

As soon as Runge and Paschen announced that the yellow line of the gas from cleveite was double, I made some observations on the helium line in the Sun; but at that time I failed to see the line double (Chem. News, No. 1855), owing probably, as I now believe, to the thin cloud present at the time. For with a bluer sky we have had no difficulty since in seeing $D_3$ as a double line similar to the terrestrial pair photographed by Runge and Paschen.

In the chromosphere close to the limb both components are usually expanded, and then the interval between them is very small, and can be seen only with some difficulty; but further from the limb, as in prominences, the lines thin out, and form a pair of very fine lines, of which the less refrangible one is much fainter.

The pair of dark lines very near the helium lines on the less refrangible side furnish a convenient scale by which the separation of the bright lines may be estimated, and showed that the helium lines were about the same distance apart as the pair of yellow lines of the cleveite gas according to Runge.

On one occasion, owing to the shift through motion in the line of sight of the expanded double helium line, a terrestrial line was seen upon it, as appears to have been the case in the observations of Bélopolsky (Mem. Soc. Spett. Ital., May 1894).

The observations were made on the spectra of the third and fourth orders of a Rowland grating having 14·438 lines to the inch. The lines were seen double on July 10, 11, and 13.

WILLIAM HUGGINS.

To appreciate the importance of Dr. Huggins' observations recorded above, it will be well to briefly recall the recent circumstances relating to the investigation of the question whether "helium," hitherto thought to be an element peculiar to the Sun, actually exists on our earth.

In making some researches on the newly-discovered Argon, Prof. Ramsay observed in the spectrum of the gas released from the mineral Cleveite, by warming with weak sulphuric acid, a brilliant line in the yellow, nearly but not quite coincident with the sodium line D (Proc. Roy. Soc. 1895, April 25). When the exact wave-length of this line was determined (587·49 mm.), the line was found to be exactly coincident with the line $D_3$ of the solar spectrum attributed to the unknown substance helium. The conclusion, therefore, was generally accepted that helium existed as a terrestrial element, until Profs. Runge and Paschen, of Hanover, making a careful determination of the wave-length of the bright yellow line in the spectrum of the cleveite gas, with a Rowland concave grating of 6·5 metres radius, showed this line double: "its less refrangible component is much weaker, but comes out quite bright when the stronger one is brilliant." The pair of lines were photographed and from measurements and interpolation with respect to the adjacent known iron lines, the wave-lengths were found to be, for the strong component $\lambda = 5875{\cdot}883$, and for the weaker $\lambda = 5876{\cdot}206$ ('Nature,' 1895, June 6)*. This seemed to negative the proposition that the line in the cleveite spectrum was due to helium, as the $D_3$ line in the solar spectrum had hitherto been supposed to be single, although it is worth remembering that Prof. Bélopolsky stated last year (Mem. Societa Spett. Ital., May 1894) that he had seen two terrestrial lines at the sides of the helium line, whose positions are now found to agree fairly well with Runge's lines. The problem therefore seemed at this point to lie with astronomical spectroscopists to determine whether the $D_3$ line in the solar spectrum is single or double; and as Dr. Huggins says, he at once set about making the necessary observations, with the result he gives above.

Prof. G. E. Hale, the eminent solar spectroscopist of Chicago, seems to have experienced the same difficulty as Dr. Huggins in seeing the duplicity in the chromosphere line close to the limb He contributes some valuable observations to the investigatio in a note of June 24, published in Ast. Nach., No. 3202:—"O June 20 I examined a bright prominence at P. A. 67°, a immediately detected an inconspicuous bright line on the l refrangible side of $D_3$ in the fourth order spectrum. Measu the separation of the components were made with a filar micrometer by Mr. Ellerman, my assistant, and myself, and gave

---

* The latest determination of the wave-lengths of the helium lines made Profs. Runge and Paschen is published in 'Sitzungsberichte der Akademie Wissenschaften zu Berlin' for 1895, June 20. In this they give the w lengths of each of the series of the lines due to helium as found from clev and compare these with the wave-lengths of the corresponding hydrogen l in the same spectrum. The differences of the reciprocals of the wave-len expressed in tenth-metres is approximately constant, showing that the hel lines have a rhythmical relation to those of hydrogen.

| | | |
|---|---|---|
| June 20. | Hale ...... | 0·354 tenth-metres. |
| „ | Ellerman .. | 0·359 „ |
| June 21. | Hale ...... | 0·357 „ |
| | Mean | 0·357 |

"On account of the position of the prominence on the Sun and its consequent motion in the line of sight, I preferred to determine the wave-length of $D_3$ in the chromosphere at the north and south poles. In the prominence both components of $D_3$ were narrow and sharp, the brighter one appearing to be the broader of the two. In the chromosphere the width of $D_3$ was found to be about 0·54 tenth-metres and the fainter component could not be seen, probably on account of the considerable width of the primary."

The wave-length of the $D_3$ line was measured on the same days with the slit tangential to the north and south poles, with reference to the iron line at $\lambda$ 5862·580 and the $D_2$ line at $\lambda$ 5890·182 (Rowland). The mean result for $D_3$ gave $\lambda = 5875{\cdot}924$. This value is less than Rowland's value for $D_3$ (5875·982) and greater than Runge and Paschen's wave-length (5875·883) for the strong component of the yellow line given by the new gas. Runge and Paschen's measure of the distance between the component lines is 0·323 tenth-metres.

On June 24 Prof. Hale was able to see the duplicity of the line in the chromosphere with much difficulty, and he suggests that the discrepancy between his measure of wave-length of $D_3$ and the smaller value mentioned above is due to the fact that his measure was affected by a small error on account of the presence of the faint component on the less refrangible side of $D_3$; also he refers to M. Bélopolsky's opinion that the duplicity of the $D_3$ line is caused by the superposition of telluric lines:—"I have examined the telluric lines to which he refers, and have found that the more refrangible one sometimes seems to cause an apparent doubling of $D_3$. The less refrangible component of $D_3$ of which I have measured the positions cannot, in my opinion, be accounted for as M. Bélopolsky suggests. It falls on the violet side of the more refrangible of the pair and not between the two lines. I have found it most clearly visible with a high sun when the telluric lines are faintest. Moreover, it is seen when the $D_3$ line is so narrow that all parts of it are less refrangible than these telluric lines."

## *The Time-Service of the Hongkong Observatory.*

The main purpose of the astronomical branch of this observatory is the determination of Local Time, and for this the observatory is furnished with a Troughton and Simms transit-instrument of

3 feet focal length and 3 inches aperture. The reticule is provided with one movable and seven fixed vertical wires, and the transits are registered on a chronograph of Sir Howard Grubb's make, which is marked from the standard sidereal clock, and is furnished with Russell's electric control. In 1884 a meridian mark was fixed 11,354 feet to the south across the harbour. The deviation of this mark from the meridian is extremely small, the unweighted mean result being less than the probable error. The azimuth error of the transit is, whenever necessary, corrected by this mark; but the azimuth error, as well as any outstanding error of collimation, is eliminated by observing objects very near the zenith—one passing the meridian to the south, the other to the north of the zenith—and reversing the instrument between the two transits. The level correction for objects passing through the zenith is applied to all stars. In this way the clock error is found without any other calculation than what is implied in taking the means. When the Moon is observed all corrections are of course rigorously applied; but the clock error is at most a few hundredths of a second out if determined in the rough way usually adopted.

The Standard Sidereal Clock by E. Dent and Co. was described by the makers as being of the very finest possible construction. The pendulum has the zinc and steel compensation originally adopted for the transit of Venus expeditions. The dial is painted black, with white hands and figures. It has a galvanic-contact apparatus that is not in connection with the clock, while the teeth of the escape-wheel rest on the pallets of the pendulum. This is found not to interfere with the quality of the rate of the clock. It actuates a three-branch relay, which marks the chronograph and drives a sympathetic dial in another room, by aid of which the standard sidereal is daily compared with the standard mean time clock.

The rate of the sidereal clock during upwards of two years, beginning with September 12, 1885, was represented by the following formula (comp. 'The Observatory' for September 1888), where $t$ signifies the number of days elapsed since the date named, and $\tau$ the temperature in degrees Fahrenheit:

$$R_c = -0^{s}\cdot56 - 0^{s}\cdot00655\,t + 0^{s}\cdot00000420\,t^2 - 0^{s}\cdot063\,(\tau - 70^\circ).$$

Its rate in 1888 was represented by the following formula, where $t$ is counted from June 28, 1888, — means gaining and + losing rate:

$$R_c = +0^{s}\cdot45 - 0^{s}\cdot00261\,t + 0^{s}\cdot0000120\,t^2 - 0^{s}\cdot063\,(\tau - 70^\circ).$$

Its rate in 1889 is represented as follows, counting $t$ from July 3 of that year:

$$R_c = +0^{s}\cdot09 - 0^{s}\cdot00197\,t - 0^{s}\cdot00000180\,t^2 - 0^{s}\cdot063\,(\tau - 70^\circ).$$

The time-service was discontinued for some time.

The rates in subsequent years were :—

1892 : $R_c = +2^s\cdot01 - 0^s\cdot063\,(\tau - 70^\circ)$ [arc$=3^\circ\,9'\pm1'$].

1893 Jan. 1–Apr. 25 : $R_c = +2^s\cdot01 - 0^s\cdot063\,(\tau - 70^\circ)$ [arc$=3^\circ\,7'$].

1893 Apr. 26–Dec. 31 : $R_c = -0^s\cdot10 - 0^s\cdot063\,(\tau - 70^\circ)$ [arc$=3^\circ\,6'$].

1894 : $R_c = +0^s\cdot08 - 0^s\cdot0028\,(t - \text{Jan. } 1) - 0^s\cdot063\,(\tau - 70^\circ)$ [arc$=3^\circ\,6'$];

but in September the clock was stopped and the pivots oiled. Since then the acceleration has disappeared, and its rate has since become

$$R_c = 0^s\cdot75 - 0^s\cdot063\,(\tau - 70^\circ)\ [\text{arc}=3^\circ\,3'].$$

In order to be able to check the rate of this clock during the lengthy periods of cloudy weather in early spring, when sometimes not a single observation can be obtained for five weeks consecutively, I requisitioned a new Mean Time clock from Mr. James Brock, of 64 George Street, Portman Square, London, which arrived in 1891. The pendulum has not mercurial compensation, but the same tubular zinc-and-steel compensation as Dent's clock, and the very heavy pendulum swings in a larger arc, so as to lessen the barometric error. The zinc is, as usual, too long. I suspect the makers use the same length always instead of experimenting on each clock individually, and they prefer to leave the zinc too long, but I do not like to undertake the cutting down to the proper length. The probable deviation of each ten-day rate from the preceding rate (corrected for temperature) is $0^s\cdot08$ in case of Dent's clock and $0^s\cdot07$ in case of Brock's. The latter is not placed in the clock-room, but in the barograph-room, where the temperature is different. Otherwise these clocks are sufficiently alike to fail to afford a check upon each other during long periods without observations.

The rates of Brock's Mean Time clock are represented as follows :—

1892 : $R_c = +2^s\cdot60 - 0^s\cdot074\,(\tau - 75^\circ) + 0^s\cdot0020\,(t - \text{July } 1)$;

1893 : $R_c = +3^s\cdot08 - 0^s\cdot112\,(\tau - 75^\circ) - 0^s\cdot0027\,(t - \text{Jan. } 1)$;

1894 : $R_c = -0^s\cdot14 - 0^s\cdot124\,(\tau - 75^\circ) - 0^s\cdot0056\,(t - \text{Jan. } 1)$.

The arc in the case of this clock began with 4° 12′ 36″ in 1892. It is now 3° 56′ 0″. The arc of pendulum swing of Dent's clock was 3° 3′ in 1884, and is now the same. Both clock-rates show the existence of waves. In case of Dent's clock the periods and amplitudes are larger, which make the errors appear greater than in case of Brock's clock, where the periods are shorter.

The rate of Brock's clock, reduced to 75°, depends upon the winding in such a way that it goes faster immediately after winding and more slowly afterwards. This seven-day period has been observed ever since the clock was started in August 1891, as is shown in the following table :—

| | Daily rate for 3 days after winding. | Daily rate for 4 days before winding. | Difference. |
|---|---|---|---|
| 1892 ...... | +2$^{s}$·583 | +2$^{s}$·651 | −0$^{s}$·068 |
| 1893 ...... | +2$^{s}$·442 | +2$^{s}$·553 | −0$^{s}$·111 |
| 1894 ...... | −1$^{s}$·392 | −1$^{s}$·336 | −0$^{s}$·056 |

The daily change of rate due to this cause has been determined for the intermediate period, and, together with the observed arc of the pendulum corresponding thereto, is shown below. It is to be remarked that the clock is regularly wound on Monday morning, and that the rate for the 24 hours subsequent to that is entered opposite to the day. The sudden increase of the arc on Saturday is due to the fact that it is then often read by Mr. Figg, whose habit of observing is to give a greater reading than Mr. I. Plummer, who has made the other observations:—

| | Rate. | Arc. |
|---|---|---|
| Monday ...... | +2$^{s}$·428 | 3° 56′ 55″ |
| Tuesday ...... | +2 ·444 | 3 56 54 |
| Wednesday .... | +2 ·455 | 3 56 46 |
| Thursday...... | +2 ·497 | 3 56 48 |
| Friday........ | +2 ·543 | 3 56 3 |
| Saturday ...... | +2 ·593 | 3 56 43 |
| Sunday ...... | +2 ·571 | 3 56 1 |

During the five years from 1885 to 1889 inclusive the time-ball has been dropped 1465 times.

The following table gives the frequency of the errors in the time of the ball-drop during this period:—

| Error less than | No. of times. | Error less than | No. of times. |
|---|---|---|---|
| 0$^{s}$·1 .... | 806 | 0$^{s}$·9 .... | 15 |
| 0 ·2 .... | 249 | 1 ·0 .... | 9 |
| 0 ·3 .... | 143 | 1 ·1 .... | 5 |
| 0 ·4 .... | 88 | 1 ·2 .... | 3 |
| 0 ·5 .... | 61 | 1 ·4 .... | 1 |
| 0 ·6 .... | 36 | 1 ·5 .... | 2 |
| 0 ·7 .... | 30 | 1 ·6 .... | 1 |
| 0 ·8 .... | 16 | | |

With a value of the probable error 0$^{s}$·15 which results from these, the theoretical frequency of error would be as follows:—

| | |
|---|---|
| less than 0$^{s}$·15...... | 733 |
| 0 ·2 ...... | 350 |
| 0 ·3 ...... | 213 |
| 0 ·4 ...... | 106 |
| 0 ·5 ...... | 43 |
| 0 ·6 ...... | 15 |
| 0 ·7 ...... | 4 |
| 0 ·8 ...... | 1 |

In my annual volume of observations and researches the details of clock-rates and errors of the time-ball are given. It is to be regretted that such details are not published in the case of many other time-balls. So-called time-balls are dropped in many places where competent observers are not available, and instead of affording assistance they form a danger to navigation. In case a colony wants a time-ball the authorities might with advantage order transits of the Moon, of Jupiter's satellites, or other similar phenomena that serve to check the longitude to be made. From the non-existence or, in the event of their existence, the quality of such observations, a judgment might be formed whether the dropping of the time-ball ought to be continued. In many cases, no doubt, the decision would be adverse to continuation.

Hongkong Observatory, 1895, Mar. 12. W. Doberck.

## *The Cœlostat**.

The principle of a Foucault siderostat—the instrument which shows the image of a star reflected in a mirror as stationary, so that it may be seen continuously by a telescope fixed in a chosen direction—is well known. In the mirror of a siderostat, however, the image of the sky itself is not stationary: the remaining stars appear to move around the selected star. Would it be possible to construct an apparatus which would give a fixed image of the entire sky, which would therefore be not a *siderostat* but a *cœlostat*? There is a solution of this problem and one only, which is here given.

A plane mirror is mounted on an axis which rests on two fixed bearings. The mirror and its axis are parallel to the line joining the celestial poles. Uniform motion is given to the system, so that it may make a complete rotation about the axis in 48 hours, in the same direction as the apparent diurnal motion of the heavens.

It can be shown that the image E′ of *any star* E whatsoever will be seen stationary in the mirror. Let O be a point in the plane of the mirror, EO an incident ray, OE′ the prolongation of the reflected ray. It follows, from elementary laws of reflection, that the plane M of the mirror is a plane of symmetry for the straight lines OE OE′. This plane, by hypothesis, lies parallel to the line joining the celestial poles; it therefore contains a line, OP, parallel to the line joining the poles. This straight line, OP, is therefore equally inclined to the directions OE OE′, for the plane of symmetry, M, is the locus of straight lines equally inclined to OE and OE′. In other words, the angles EOP, E′OP are equal. The angle EOP is the polar distance of the star, and, consequently, independent of the time; the same applies to E′OP. On the other hand, the plane EOP turns about OP with a velocit (which is that of the diurnal movement); and we have gi an angular rotation $\beta$ to the plane M around OP; the plane E turns therefore with a velocity $2\beta - \alpha$ around OP. By hypoth $\beta = \frac{1}{2}\alpha$ (one revolution is made in 48 hours). Thus the velo $2\beta - \alpha$ is zero, and the plane E′OP is therefore stationary. straight line OE′, which lies in the stationary plane E′OP, m with the fixed direction OP an angle E′OP independent of time. This straight line is therefore fixed, and, in short, image of any star whatever is stationary.

---

* By M. G. Lippmann. Translated from 'Comptes Rendus,' Tome cxx. No. 19, 1895 May 13.

It may be added that the solution of the problem is unique, that the conditions detailed above are necessary. For the po is fixed during the whole rotation; its image P′ also is to be f just as all the other points of the sky are; and in order that image of a fixed point seen in a moving mirror may be fixed, i necessary that the point must be on the mirror; that is to say other words (for in reality the points P and P′ are at infin that, in order that the image OP′ of a fixed direction OP ma fixed, it is necessary that the moving mirror should be par to OP.

The image of the sky seen in the mirror being fixed, it appear fixed when seen in the focal plane of an ordinary teles or a photographic telescope on a fixed stand and directed to mirror. The apparatus therefore acts as an equatorial.

As to the direction to be chosen for the observing telescop is not possible, as with the siderostat, to direct the telescop any horizontal line whatever, for the polar distance of the im of a star is equal to that of the star itself. If the group stars observed rises and sets, and one wishes to observe in a h zontal direction, the observing telescope should be turned to point of the horizon where the group sets or rises. In fact azimuth of the horizontal observing telescope will be fixed by declination of the stars under observation, and the initial posi of the mirror depends on their hour-angle *.

The apparatus is more convenient to use than the stra equatorial, for it does not necessitate the observer changing position.

The principal advantage is that it is possible to make an strument of great precision on account of its simplicity. bearings of the axis could be supported by a pillar of masonry could carry an axis so solid that it would not bend under small weight of the mirror. Great stability would be pos without appreciable flexure.

A telescope furnished with a reticule being pointed on mirror, an apparatus is formed which has the same propertie an equatorial, and which might be adjusted and its adjustm improved by the same astronomical methods as for an equato with some variations which need not be entered on here.

---

* But there is a limit to the use of a horizontal telescope.

With an equatorial, however perfect, the motion of the stars nevertheless is not exactly followed, owing to refraction and atmospheric perturbations. With this apparatus it would be sufficient to supply the observing telescope with small adjustment screws, and thus follow the stars without touching the mirror.

---

## *A New Method of Determining the Velocity of Stars in the Line of Sight.*

[The following extracts from an article in Ast. Nach., No. 3289, by Herr Artémie Orbinsky, describe a method of finding stellar velocities based on the fact of irrationality of dispersion of a prismatic spectrum. There is no question of the ingenuity of this suggested method, but it seems that, as the measured quantity on which the determination depends is so small, it might be masked by instrumental and observational errors which might not be the same for the two stars under examination, which might be in different parts of the sky. But in the case of stars of Type II., where many lines are available, the mean of many measures might be free from such errors. We call attention to Prof. Vogel's favourable criticism, which points out the advantages of the method.—Eds.]

The radial velocities of stars are at present generally determined by one of three methods:—1. By measuring directly the distance between the lines of the spectrum of the star and the corresponding lines of a known spectrum, that of hydrogen for example (Dr. Huggins and others). 2. The method of Prof. Vogel (Publicationen des astrophysikalischen Observatoriums zu Potsdam, Bd. i. Th. 1, Messmethode). 3. M. Dunér, in his "Recherches sur la Rotation du Soleil," measured the distances of solar lines in the spectrum from neighbouring telluric lines. (See also Henry Draper Memorial, First Annual Report, Cambridge, Mass., 1887.)

I suggest here the following additional method. Let V be the velocity of light, $v$ the velocity of the star in the line of sight: by the Doppler-Fizeau principle $\Delta\lambda = \lambda\frac{v}{V}$, where $\Delta\lambda$ is the variation of wave-length $\lambda$ caused by the velocity $v$. Denoting by $n$ the number of revolutions of the micrometer which measure a micro-millimetre of wave-length, and taking the revolution of the micrometer as unit, for two rays of wave-length $\lambda_1$ and $\lambda_2$ we have

$$d\lambda_1 = n_1\Delta\lambda_1 = n_1\lambda_1\frac{v}{V}, \qquad d\lambda_2 = n_2\lambda_2\frac{v}{V},$$

and

$$v = V\frac{d\lambda_1 - d\lambda_2}{n_1\lambda_1 - n_2\lambda_2} \quad . \; . \; . \; . \; . \; . \; . \quad (A)$$

So we get the absolute velocity of the star if the distances $d\lambda_1$ and $d\lambda_2$ are measured relatively to the corresponding rays of the spectrum of a stationary source of light.

If, then, photographs of the spectra of two stars are taken (either by a spectrograph, such as Prof. Vogel's, or by means an objective prism) side by side on the same plate, it would possible to measure $d\lambda_1$ and $d\lambda_2$, which will be the distances the lines of one spectrum from the corresponding lines in t spectrum of the other. These measures being differential cou be made with great exactness, as Prof. Vogel has shown. T constants of the spectrograph being known, the formula (A) w give the velocity of one source of light, that of the star und discussion, relatively to that of the other, the comparison st Naturally the wave-lengths $\lambda_1$ and $\lambda_2$ should be corrected for t motion of the comparison star, which is supposed known; but th correction will be negligible in most cases.

The formula (A) shows that the result will be more reliable the difference $n_1\lambda_1 - n_2\lambda_2$ is greater. Hence it is advantageo that (1) the limits of the photographed spectra may be as wide possible, and (2) that the prism (or system of prisms) employ should give a difference as great as possible between the dispersi of the two ends of the spectra. Under ordinary conditions spectroscopy these two conditions are contrary to one another, b the second is much more important than the first. It will also seen that prismatic spectra which give a great difference betwee the dispersion at different parts of the spectrum are more suitab than diffraction spectra.

To show the order of magnitude of $d\lambda_1 - d\lambda$ the followin examples are given:—1. In Prof. Vogel's spectrograph of tw prisms a radial velocity of 10 kilometres corresponds to a value $d\lambda_1 - d\lambda_2 = 0\cdot0085$ mm. if the part of the spectrum between wav length 468 and 410 is used, whilst the displacement of the line H for the same velocity is 0·0125 mm. 2. In the Harvard Colleg spectra, obtained with a prism of 20° refracting-angle plac before the object-glass of the Draper telescope, the same velocit of 10 kilometres is represented by $d\lambda_1 - d\lambda_2 = 0\cdot0320$ mm., usin the part of the spectrum between wave-length 489 and 395.

All that has been said pre-supposes the variability of the posi tion of the prism system relatively to the pencils of light fro both sources. This is assured in Prof. Vogel's spectrograph, bu is not necessarily so in the Fraunhofer spectrograph; and th following remarks apply to this instrument. The changes o position of the prism relatively to the object-glass may be divide as follows:—(1) Those affecting the parallelism of the two spectr (rotation of the prism between two positions around the optica axis of the telescope): this correction may always be neglected and (2) those which displace one spectrum longitudinally wit respect to the other but do not affect the parallelism (changes o position of the prism relative to the optical axis of the objective) If the refracting edge of the prism is placed parallel to the diurna motion of the star, this latter displacement becomes mixed up wit the displacement produced by bad settings in declination. Wit regard to the second fault, if $i, r, r', i'$ are the angles made b the ray of the light analyzed, consecutively with the two refracting surfaces of the prism,

$$\frac{di}{di'} = -\frac{\cos r\ .\ \cos i'}{\cos r'\ .\ \cos i} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (B)$$

If the prism is at nearly the minimum deviation of the ray determined, H$\gamma$ for example, then for this ray $di = -di'$ nearly. The angular scale of the plates (focal length of the objective) being known, the angular distance between the rays of the same wavelength could be measured in both spectra, and would give $di'$ and, consequently, $di$.

With $di$ we can calculate in (B) the variations $di_1$ and $di_2$ of the rays, by means of which the radial velocity is determined. In transforming these angular quantities into linear (by multiplying them by the focal length of objective and by the secant of the angular distance between these rays and the ray, H$\gamma$ for example, for which the prism is at minimum deviation) their difference is taken, and with it the quantity $d\lambda_1 - d\lambda_2$ may be corrected.

I would remark that the method retains the advantages of that of M. Vogel, in which a number of lines may be used: it proposes to dispense with artificial spectra; it introduces measures obtained with the prism before the objective; it enables us to deduce absolute radial velocities from observed relative velocities, and if the radial velocities of a number of the brighter stars are well determined by such instruments as at Lick, these could be used for comparison stars. ARTÉMIE ORBINSKY.

*Remark on the above article by H. C. Vogel.*—Adopting a velocity in the line of sight of 10 km. for a star, I find for the Potsdam spectrograph $d\lambda_1 - d\lambda_2 = 0{\cdot}0065$ mm. ($\lambda_1 = 410\ \mu\mu$, $\lambda_2 = 416\ \mu\mu$), and the displacement of the H$\gamma$ line 0·0112 mm. There can be no doubt that the above method in the hands of a skilful and careful observer can give results comparable in accuracy with the latest determinations of the velocity of stars in the line of sight. It promises the great advantage of utilizing the strong light of the objective prism for estimations of motion in the line of sight, which up to now could in general only be employed in studying the form of spectra.

---

## *Selenographical Notes.*

THE LAPLACE PROMONTORY AND THE REGION NORTH OF THE SINUS IRIDUM.—Under whatever aspect it is viewed, the imposing inflection in the outline of the north-eastern side of the Mare Imbrium, known as the Sinus Iridum, must be classed as one of the most striking and beautiful formations on the Moon's visible surface, but more especially so at that particular phase when the

innumerable peaks towering above the mountains which define
limits are first illuminated by the rising Sun, while the surface
the bay immediately below them is still in darkness. At this ti
the shadow of the magnificent mountain-mass, constituting t
Laplace promontory which rises to more than 9000 feet above
base, with those of other neighbouring outlying heights, and grou
of long low winding ridges, resembling banks left by the tide o
smooth level beach, gracefully bending inwards as if influenced
waves flowing towards the shore of the bay, make up a telesco
picture on which one is never weary of gazing.

The promontory itself, which presents a nearly vertical front
the Sinus and projects considerably from its shore-line, is s
mounted by a good-sized but shallow depression with a bri
interior, having a duskier companion adjoining it, while a thi
much deeper, stands at a lower level on the eastern flank of t
slope, and a fourth lies some little distance north of the gro
near the edge of the western face of that part of the cliff whi
faces the Mare Imbrium. All these objects may be easily ide
tified at the phase in question in a 4-in. achromatic, though th
are doubtfully shown in the maps. The eastern sides of the fi
and the fourth seem to be connected by a steep straight wall-li
ridge, which casts a very distinct black shadow. The southe
end of the very peculiar and irregular formation Maupertuis
connected with the mountain-barrier of the bay by two passes
least, which run steeply down to its dark interior, which lies so
thousands of feet below its summit. This formation is pe
shaped, widening out towards the north. Its rampart on t
west is nearly straight and of small altitude when compared wi
the more broken and massive sections on the north and east, t
latter being conspicuously terraced. Schmidt shows a wide vall
bounded by lofty walls in the interior running south from
notable gap in the north wall. I have not succeeded in seei
this as he shows it, though 5 distinct mountains have been not
on the floor, representing probably the loftier portions of t
sides of the valley. Between $9^h$ and $10^h$ June 2, this year,
obtained a fine view of the region, the termination of the He
clides promontory being just in sunlight. At this phase t
country north of Maupertuis and the Sinus presents a very striki
appearance, due to the well-nigh innumerable rill-like valleys
every degree of delicacy, extending for miles in a nearly paral
direction from south-east to north-west. With a low power th
resemble more than anything the striations on a glaciated ro
though under greater magnification they are seen to be groo
varying in depth and breadth, almost every example exhibiti
many local spindle-shaped expansions in its course. Schmi
draws as coarse clefts a few of the most prominent of the
curious formations, but does not show a tithe of those whi
actually exist. Some of them, but by no means many, a
evidently associated with craters. This is especially the case wi

those near the shore-line of the Mare Imbrium, north of Maupertuis, where the craters *b* and *d* in Neison's Map vii., and five others, which he omits, are evidently connected with the valleys. I can recall no other region where the striation of the surface in this peculiar fashion is so prominently displayed; the interior of J. F. W. Herschel is the only other instance which can compare with it in this respect. T. Gwyn Elger.

Beaumont House, Shakespeare Road,
Bedford, 1895, July 19.

---

## OBITUARY.

* On the 7th of July this year, Professor Dr. Friedrich Wilhelm Gustav Spörer, the chief observer in the Astro-Physical Observatory at Potsdam, died suddenly of palsy of the heart.

Spörer was born in Berlin on Oct. 23, 1822. He received his earlier education at the Friedrich-Wilhelm's Grammar School, and in 1840 proceeded to the Berlin University, where he devoted himself to the study of Mathematics and Astronomy. He took his degree in December 1843, and in the following year was employed as a computer at the Berlin Observatory under Encke. In 1846 he adopted the profession of teaching, and in 1849 obtained a post at the Grammar School at Anclam, where he stayed 25 years, finally occupying the post of Prorector of the Institution.

From the year 1860 his predilection for astronomy induced him to spend his leisure time in the observation of sun-spots. The fact that he succeeded, with very inferior instrumental help, with a small telescope provided with a ring-micrometer, in making the valuable researches relating to sun-spot statistics, which soon made his name known in the scientific world, is a proof of unceasing diligence and great perseverance. Prof. Shellbach, the tutor of the then Crown Prince Frederick William (afterwards Emperor Frederick), directed his distinguished pupil's attention to Spörer, and in the year 1868 the Crown Prince assisted Spörer's efforts by providing him with a refractor of 5 inches aperture, with clock-work movement, with which he could thenceforth carry on his observations to a greater extent by the known method of projections. The results of his researches pursued in Anclam have been published in numerous articles in the Ast. Nach., and also in two larger treatises which appeared in 1874 and 1876 as publications of the Astronomical Society. The great value of these works lies in the careful determination of the rotation-period of the Sun, and also in the approximate establishment of the law already discovered empirically by Carrington, which gives the

---

* Translation of advance proof of the Ast. Nach., kindly communicated by Prof. Vogel.

diminution in the speed of rotation of the sun-spots as the la
varies from the equator to the pole.

In the year 1868 Spörer took part with Prof. Tietjei
Dr. Engelmann in the astronomical expedition which wa
from Germany to observe the total solar eclipse in the East I

In the year 1874 Spörer obtained an appointment as obser
the Astro-Physical Observatory, then established at Potsdan
the same year he settled in that city, and helped the w
the Observatory by carrying on observations of sun-spots wi
instrument, which had been placed on the tower of the M
Orphan Asylum.

His activity evinced itself still more in the larger sphere of
which he marked out for himself at Potsdam, still confined
domain of sun-spot statistics, to which he devoted himself
untiring faithfulness, and with the same zeal as at Anclam.
four extensive treatises composed by him, which were printed
publications of the Astro-Physical Observatory between 187
1894, contain observations which will be of permanent val
the study of the proper motion of sun-spots.

In the year 1882 Spörer was promoted to the post of
observer. This position he occupied until the 1st of October,
when, in consideration of his advanced age, he received th
charge he applied for, and retired to his well-earned rest, v
unfortunately, he was not permitted long to enjoy.

Spörer's life was rich in happiness and tangible results,
thanks to his robust health, he remained free from the dis
of old age to the day of his death. During a visit to his ch
he passed away gently and painlessly, without the sli
previous indication of any illness.

Dr. Spörer was elected an Associate of the Royal Astron
Society, 1886 Nov. 12. H. C.

*On the 21st of June, 1895, at Berlin, the death occur
Dr. Friedrich Tietjen, Professor of Astronomy at Berlin
versity, Director of the computing Bureau attached to the
Observatory, and Editor of the *Astronomischen Jahrbuch.* T
was born at Garnholt, near Westerstede in Oldenburg, i
year 1834. He studied Astronomy at Göttingen and Berli
since 1861 was actively employed in the Berlin Observato
University until two days before his death, which was the
of heart-disease.

His most important labours lie in the region of astrono
computation. Himself an exceedingly accurate and rapid
puter and highly gifted mathematically, he has not only done
useful work as director of the computing Bureau and o
*Jahrbuch*, but also in the work of an astronomical training-co
conducted by him jointly with the writer of this. He has

---

* By Prof. Foerster (Ast. Nach. No. 3301).

contributed directly to the progress of the science by his contributions to the theory and method of the determination of orbits and computation of perturbations, and of astronomical ephemerides. Unfortunately, approaching weakness had for some long time past kept him from several very beautiful investigations of a theoretical and computational nature, on account of the labour involved in their publication, and much has perished with him.

As a colleague and friend he was full of spirit and character, but at the same time a man of particularly homely manners. Highly honoured and beloved, his memory will live on in high esteem, not only in the Berlin Observatory and University, but also doubtless in the widest circles of our science.

Dr. Tietjen was elected an Associate of the Royal Astronomical Society, 1881 June 10.

---

* Dr. O. A. L. Pihl was born at Stavanger, Norway, on Dec. 5, 1822. After being educated in Sweden he spent eight years of his early life in England, working at the profession of engineering under, among others, the famous John Ericson and Robert Stephenson. In 1850 he returned to his native country, where he was occupied as a director of a gas manufactory until his death.

Dr. Pihl's taste was first directed to Astronomy during his residence in England, where he made the acquaintance of Dr. Lee of Hartwell. At his house in Christiania he established a small observatory with an instrument of 81 mm. aperture, with which he made a series of observations published in 1869 under the title "Micrometric Examination of the Stellar Cluster in Perseus." Later he made a second series of observations of the same region, and afterwards devoted himself to the study of occulting micrometers, and some phenomena connected with their use. The results of these works are published in two papers, "The Stellar Cluster $\chi$ Persei Micrometrically Surveyed," 1891, and "On Occulting Micrometers and their Value as applied to exact Astronomical Measurements" (1893).

Dr. Pihl spent much leisure time in the construction of electric clocks, of which he had many made by his own hands. This led him to the study of magnetic attraction at short distances, which he, not being equal to the higher mathematics of the subject, attacked experimentally. He published a work 'On Magnets' as a supplement to the Memoirs of the Christiania Society of Sciences (1877).

Dr. Pihl died on July 1st last of Bright's disease. He was elected a Fellow of the Royal Astronomical Society 1860 Nov. 9.

George William Herschel Maclear, the son of Sir Thomas Maclear, then H.M. Astronomer at the Cape, was born on July 25, 1836, at the Cape Observatory. Sir John Herschel, his godfather, who was then making his celebrated series of observation Feldhausen, recommended an Indian career for his godchild, was educated with that view; but a vacancy occurring on the at the Cape led his father to appoint his son George tempor to the post, merely as an expedient to help the work of observatory. The temporary appointment was, however, ma permanent one, and the Admiralty made Maclear an assistan June 26, 1852, which post he ably filled almost until the tim his death. Mr. Maclear seldom left the observatory. In he went to Durban in connection with the operations for de mining the difference of longitude between the Cape and A and his brother, Admiral Maclear, states that the first and time he was in England was in 1892. He may almost be sai have died at his work, for the paralytic seizure to which he e tually succumbed occurred whilst reading the rainfall duri severe thunderstorm in April 1892. Mr. Maclear died on W nesday, June 26. He leaves a family of three sons and t daughters, one of whom is married to Prof. Jacoby, the w known astronomer of Columbia College, New York.

---

* By Prof. Geelmuyden (Ast. Nach. No. 3302).

---

## CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

### *Nebula No.* 6595 *of the New General Catalogue.*

GENTLEMEN,—

In the New General Catalogue of Nebulæ, object No. 6 (G.C. 4395) is described as "Faint, pretty large, consider elongated, a double-star involved." The same object has b mentioned by Sir John Herschel in the 'Philosophical Tran tions' for 1833 as "A double-star in a faint nebula," and he so figured it.

In the 'Cycle of Celestial Objects' (second edition) the aut however, remarks that "to my instrument the stars have ou glow and some gleamy points of light around them."

Neither Admiral Smyth nor his editor, Mr. Chambers, thought fit to point out that the discrepancy in the descript was most likely due to the great differences in the apert employed, and from the context one is apt to doubt of objective reality of Sir John Herschel's nebula.

I have therefore thought fit to photograph the object with 16½" reflector. On the plate the loose double-star (distance is obtained distinctly surrounded by nebulosity, and in my hu opinion there can be no doubt regarding the existence of nebulous envelope as described by Sir John Herschel.

Yours truly,

Poona, 1895, June 7. K. D. NAEGAMVA

## *The Periodicity of Jupiter's Markings.*

Gentlemen,—

Capt. Wm. Noble has suggested a cyclical movement of the Jovian markings, and has prepared 25 drawings of the disk, ranging over a period of 21 years, to illustrate the probability of this conjecture. As the problem is a complex one, it is thought desirable there should be a large accumulation of data for a satisfactory discussion, and that the research should be extended to remote reliable observations, embracing as many published and private drawings that may be accessible. The Jupiter Section of the British Astronomical Association will probably engage in this work, but the contributions of Jovian students of every nationality will be heartily welcomed. The writer would suggest the formation of a small committee of Jovian experts for the reception and discussion of data. It is hardly premature to express the hope that Capt. Noble, Prof. Keeler, Messrs. Stanley Williams and N. E. Green will consent to form the nucleus of such committee. The above names would ensure the confidence and elicit the activities of contributing observers, and probably lead to reliable conclusions. Detailed suggestions as to special points of observation and brief interim reports would aid in keeping up an interest in the research and securing the necessary accuracy.

Yours faithfully,

Portland, 1895, July 15. W. R. Waugh.

## *Occultation of Regulus.*

Gentlemen,—

There was one point to note in the above occultation, on June 26. There was no apparent lingering at the lunar limb as was noticed for 1½ second the last time I saw Regulus occulted. The Moon was in mist, but immersion was well seen at $7^{h}\ 56^{m}\ 12^{s}$; quite instantaneous, as was also the case in 1858. Emersion $8^{h}\ 46^{m}\ 11^{s}$. The same telescope and eyepiece employed as on 1887 October 13. The emersion on that occasion also happened in twilight.

For the earliest recorded occultation of this star we must probably go back to a date corresponding to A.D. 501 March 16, when Gaubil found an observation was recorded by the Chinese, as published in the 'Connaissance des Temps' for 1810. Two other similar occultations of Regulus are mentioned in the Chinese annals during that century.

Faithfully yours,

Melplash Vicarage, Bridport,
1895, July 23.
S. J. Johnson.

[We are able to confirm Mr. Johnson's observation of instantaneous disappearance. The occultation was observed at Greenwich under very favourable circumstances, and the disappearance and reappearance both happened instantaneously.—Eds.]

## OBSERVATORIES.

MADRAS.—The report of the astronomical work of this Observatory for the year ending 1895, March 31, was summarized by the Director at the Meeting of the Royal Astronomical Society, as reported in our last number. In his official Report to the Chief Secretary for India, which is just to hand, we find, however, some additional information. Prof. Michie Smith appears to have had some trouble with his instruments. First with the transit-circle the level errors as determined by the Director and by his assistant showed systematic differences. The substitution of an amalgamated copper mercury trough for the old wooden one, while it improved the reflected image of the wire, did not get rid of the discrepancy in the results, which was eventually found to be due to a looseness of the lenses of the object-glass, causing the magnitude of the determined error to depend on the direction in which the telescope was turned to bring it to the nadir position. The observing-clock Shelton has suffered from accidents, the first being the breaking of the line supporting the driving weight. Prof. Michie Smith says that it is difficult to get a suitable driving-line for India, both gut and silk quickly deteriorate. The 6-inch equatorial is considerably damaged, and, in fact, reading between the lines of the report, it seems that this telescope and the spectroscope used with it barely deserve the name of instruments of precision, and that it is not a moment too soon for Madras to have a new observatory and equipment.

There seems to be some uncertainty as to the correct latitude of the observatory. From Mr. Pogson's observations of circumpolar stars (2787 in number) which Prof. Michie Smith is now reducing, the correction to the adopted latitude resulting is $-0''\cdot74$. From a comparison of the polar distances of 91 stars contained in the first two hours of R. A., which are also in the Greenwich 1880 catalogue, the mean difference of N.P.D. Madras − Greenwich $= -0''\cdot50$, which, if this difference be due wholly to error of Madras latitude, would indicate a correction $-0''\cdot50$; the value of the correction found some years ago by the G. T. Survey, by zenith sector observations, was $+0''\cdot67$. But as the errors of the Madras circle which are not yet wholly determined, and are probably not small, have not been applied to these observations, little can be deduced from this comparison.

In the meteorological branch the Observatory appears to be well equipped. Two new self-recording instruments were obtained during the year. One of these is an electrically recording rain-gauge, which, the report says, has been tested and works very much more satisfactorily than the syphon-gauge. Madras is ahead of many other observatories in this particular. The other new instrument is an improved form of Robinson's anemometer, which works satisfactorily.

Windsor, New South Wales.—Mr. Tebbutt's report for the year 1894 shows that a considerable amount of observing has been done, notwithstanding the fact that the astronomical staff, which consists solely of the proprietor of the institution, took a little respite from work during the year. Mr. Tebbutt seems to have been fortunate in his weather, for he was able to observe the daylight occultation of Venus on May 1, the transit of Mercury on Nov. 10, the occultation of Antares, both disappearance and reappearance, in daylight on Oct. 31; and he only just missed the daylight occultation of Spica on Nov. 24, owing to a smoky atmosphere. Besides these, he observed altogether 48 phases of occultations of stars, Comet Gale on 27 nights, and Comet Tempel 1873 II. on two occasions. Measures of some double stars have been made, which have been communicated to the Royal Astronomical Society, and the usual meteorological observations and transit observations for time.

The new building to house the 8-inch equatorial, which was mentioned as having been begun in last year's report, is now completed.

Meudon Physical Observatory.—At the meeting of the Paris Academy of Sciences on June 10 last, M. Janssen reported that the dome covering the equatorial carrying visual and photographic telescopes is now finished, and he took the opportunity of making some remarks on the unsatisfactory state of the finances of the institution, by way of explanation of the delay in issuing publications from this observatory.

It appears that the sums voted for constructional purposes have not been sufficient (it will be remembered that the observatory was originally a château which has been, or, rather, is being adapted to its present purpose), and also that the ordinary annual income has been occasionally reduced, which would have entailed a partial stoppage of the physical investigations; but to prevent this, and also as M. Janssen has been anxious to get the equatorial at work, he has, to meet the cost of the dome and of the other services mentioned, drawn on the sums provided for publication. He has therefore been able to publish only a very few specimens out of the many excellent solar photographs taken at the observatory, and has had to content himself with occasionally publishing results in the 'Comptes Rendus.' The material for several volumes of the 'Annals' of the observatory has accumulated, and only waits for provision of the necessary expenses to appear.

## NOTES.

Comet Notes.—H. I. Zwiers investigates in Ast. Nach. 3293 the orbit of Comet 1892 III. (Holmes). About 600 observations are available, extending from 1892 Nov. 9 to 1893 March 15.

The personal equations of the different observers are investigate and, as the comet underwent a remarkable change of aspect abo Jan. 16, 1893, they are independently determined before and aft this epoch. Perturbations by the Earth, Mars, and Jupiter a computed and applied, the following being the resulting elemen and their probable errors:—

| Epoch 1892 Nov. $4^{d}$·0 G.M.T. | | | Probable Error. |
|---|---|---|---|
| $M_0$ ...... | 73842″·0 | | 42″ |
| $\pi$ ........ | 345° 57′ 26″ | 1892·0. | 93 |
| ☊ ...... | 331 41 34 | | 27 |
| $i$ ........ | 20 47 16 | | 6 |
| $\phi$ ........ | 24 10 46 | | 11 |
| $\mu$ ........ | 514″·04 | | 0″·14 |
| log $a$ .... | 0·55934 | | 0·00008 |
| Perihelion Passage | 1892 June $13^{d}$·35 | | $0^{d}$·09 |
| ,, | 1899 May 9 ·55 | | 0 ·72 |

The next apparition will therefore take place under simil conditions to that of 1892. Herr Zwiers proposes to investig the perturbations up to 1899 and publish an ephemeris.

Prof. Porter publishes, in Astron. Journ. 347, revised elemer of Comet 1892 V. (Barnard). He has included some observatic not published at the time of his previous investigation, but l apparently overlooked that made at Nice on Dec. 8.

| Epoch 1892 Oct. $22^{d}$·5 Berlin M.T. | | |
|---|---|---|
| $M_0$ .... | 352° 4′ 2″ | |
| $\pi$ ...... | 17 10 44 | 1892·0. |
| ☊...... | 206 45 45 | |
| $i$ ...... | 31 9 0 | |
| $\phi$ ...... | 35 13 15 | |
| log $a$.... | 0·52756 | |
| Period .. | $6^{y}$·18 | |

The period is 4 months shorter than that given by M. Coniel

A. C. D. C

MINOR PLANET NOTES.—Two new planets BZ and CA (p visionally) were discovered by Charlois on July 23, No. 392, d covered by Wolf, 1894 Nov. 4, has been named Wilhelmina.

A. C. D. C

A MECHANICAL INTERPRETATION OF THE VARIATION OF LA- TUDE.—Assuming the variation of position of the Earth's axis rotation to be a fact established by observation, the next st would appear to be to investigate the dynamical causes of t variation. The dynamics of the subject has already been attack by several mathematicians, the latest research being by Mr. R. Woodward in the 'Astronomical Journal,' No. 345. This pa commences with a brief account, containing full references to the original papers, of the method of obtaining the equations of motion of a body of variable form. In the case of the Earth, where the changes are slow, these reduce to two linear equations, giving the position of the axis of rotation relatively to the axis of figure. It is first shown that no admissible difference of the Earth from a spheroidal form is available to account for the observed departure of the motion of the Pole from the Eulerian Cycle. The author then considers what type of solution of the equations he has obtained will agree with the observations, and concludes that the minute angular velocities resulting from the tides generated by the rotation of the axis of the Earth about its axis of figure afford an explanation, the possible distortion of the Earth as a whole contributing to the same result. The paper concludes with a consideration of the effect of earthquakes &c., sedimentation, and meteorological disturbances on the motion of the pole. Mr. Woodward has treated the question very clearly, and has demonstrated —and more, it seems to me, cannot be done without hydrodynamical investigations—the reasonableness of the explanation he offers of the lengthening of the Eulerian Cycle. In justification of the view that a fuller hydrodynamical treatment is necessary we would refer the reader to an abstract of a paper by Mr. Hough given in the 'Proceedings of the Royal Society' for 1895 March, in which the author states that mobility inside the Earth has the effect of diminishing rather than increasing the Eulerian Cycle.

F. W. D.

---

A Proof of the Law of Gravitation.—The suggestion has been made at times that the force of gravitation does not accurately vary as the inverse square of the distance between the attracting bodies. It will be remembered that this hypothesis has been adopted to account for a certain observed motion of the apse line of Mercury's orbit ('Observatory,' Vol. xvii. p. 284). In a recent note in the 'Astronomical Journal' (No. 346) Mr. C. H. Kummell endeavours to show from elementary considerations that this hypothesis is untenable, and that the law must be as generally accepted.

His proof, in fact, amounts to this:—If the force of gravity does not vary inversely as the square of the distance, in equations which involve the attraction of two bodies, the *dimensions* on the two sides of the equation will not be equivalent. Thus the force of attraction between the bodies is represented by

$$k\cdot\frac{m\,m'}{r^2},$$

and a force is represented typically by $Mf$; therefore

$$k\cdot\frac{m\,m'}{r^2}\text{ is equivalent to }Mf.$$

Here, as a mass is of three dimensions in length and $f$ is of one dimension, each side is of four dimensions in length ar equivalence holds; but if $r^{2+\delta}$ were substituted for $r^2$, the lef hand side would be of $4-\delta$ dimensions in length: hence a for of gravity varying as any power of the distance except the inver square will not satisfy our dynamical conventions.

There appears to be a fallacy in this reasoning, and as a kind *reductio ad absurdum* it might be pointed out that time is involve in the right-hand expression but not in the left-hand. The err seems to occur in assuming that *k*, the astronomical constant gravitation, is an abstract number. And should *mass* be co sidered as having *length*?

---

THE COMPARATIVE USEFULNESS OF LARGE AND SMALL TEL SCOPES.—We are very glad to see an observer of the acknowledg excellence of Mr. W. F. Denning taking up the question of t recent marvellous performances attributed to small telescop If it be true that large telescopes fail to show appearances readi seen in small telescopes, and that these appearances are real, th it follows that the ordinary 2-inch finder is the proper instrume to work with rather than the telescope carrying it. Let us perfe this, and save outlay on large object-glasses.

In 'Nature' for July 4 Mr. Denning remarks:—"The phen menal results recently claimed for certain small telescopes a almost of a character to shake even the faith of those disposed acknowledge their great utility on several classes of objects, f our confidence cannot go beyond reasonable limits; . . . some the results lately published border upon romance, and hencefort it would seem that if all the data derived with such means are be absolutely accepted, then large telescopes may as well be packe away in the lumber-rooms of our observatories."

Mr. Denning then refers to Stanley Williams's observations markings on Saturn, which, "if fully confirmed, are deserving be ranked among the best observational feats of modern times to the discovery of the canals of Mars by Schiaparelli with 8½-inch refractor, of which, during a favourable presentation Mars in 1892, the large American telescopes showed very litt either of the canals or their duplication; and to the remarkab performances of Mr. Brenner with a 7-inch refractor.

The fact is that such questions as these can only be decided careful trials of large and small instruments, side by side. Wh we find Prof. Barnard systematically neglecting the 36-inch a devoting his time to the 12-inch, we may begin to suspect there something to be said in favour of small telescopes. We prefer wait till then.

---

THE DROUGHT OF 1895.—The copious "St. Swithin's" rai which commenced on the 18th of July, and in the succeeding seve days produced a greater downpour than the three months' rainfa for April, May, and June, may be considered to have put effectual stop to the severe and long-continued drought of 1895, which will now worthily take rank with the historic drought which formed so prominent a feature in the year 1893. It will be remembered that the 1893 drought extended practically over a period of nearly four months. The rainfall at the Royal Observatory in these four months of 1893 (March to June) amounted to 1·904 inch on 27 days, showing a deficiency, as compared with the average amount, of 5·24 inches. In 1895, for the period of 108 days from April 1 to July 17 the rainfall amounted to 2·335 inches on 33 days, and a deficiency, as compared with the average, of 4·66 inches. Expressed in percentages of the average amounts, the 1893 value is 27 per cent., and that for 1895 is 33 per cent. But deficient rainfall has characterized the year 1895 throughout, the amount for the six months January to June only reaching 5·18 inches, and being no less than 5·44 inches below the corresponding average. This amount fell on 68 days. Included in this are two phenomenal monthly falls, that for February, 0·22 inch derived from four small falls of snow, and that for June, 0·21 inch on 8 days, the latter being the smallest recorded value for the month of June since the commencement of reliable observation in 1841. In June 1849 the amount was 0·30 inch, and in June 1870, 0·39 inch. In 1893 the six months' rainfall (Jan. to June) amounted to 6·07 inches, being 4·55 inches below the average amount. This fell on 64 days.

Mr. Symons, who devoted considerable research to the remarkable drought of 1893, has given a list of 25 stations in the south of England ('British Rainfall,' 1893, p. 140) at which a partial drought prevailed for 115 days or more, and states "that in the extreme case the values practically amount to *four months with one inch of rain*—that is to say, about one-eighth of the usual fall." And he then expresses his belief "that possibly few of us would live to see a more remarkable drought." Examining 1895 we find that at Greenwich we have a fall of 1·08 inch in 81 days between April 28 and July 17, so that it is probable that Mr. Symons's voluminous returns may yield results for many stations correspondingly startling to those given in 1893.

---

There is a note in Symons's 'Monthly Meteorological Magazine,' on recording rain-gauges, which incidentally criticizes some British observatories. The immediate cause of complaint is that some thousands of pounds have been spent on a new Brussels Observatory at Uccle, but no provision appears to have been made for a self-recording rain-gauge.

The note goes on: "Brussels Observatory is not alone in this unpreparedness. Greenwich Observatory has no recording rain-gauge, except the antiquated one put up among the chimney-pots about 1840: so with the other public observatories—Cambridge has not one, nor Bidston, nor Edinburgh, nor Dublin."

Then follows a list of 22 stations provided with one or more.

---

**Astronomical Journal Prizes.**—Messrs. A. Hall, Lewis Bos and Chandler, who are the judges to determine the award of the prizes, have given Prize No. I. 1895, of $200, to the observer wh subject to certain conditions, made the best series of determinatio of maxima and minima of variable stars, to Mr. Paul S. Yendell.

The only manuscript received in competition for Prize No. I of $400, "For the most thorough discussion of the theory of th rotation of the Earth with reference to the recently discover variations of latitude," was from Prof. S. Newcomb, to whom th prize has been sent.

---

The Shahzada with his suite visited Greenwich Observato on the evening of Monday, July 8. It fortunately happened be a brilliantly fine evening, and the Royal visitor, whom th Astronomer Royal received, was able to have a view of the Mo and some interesting stars through the 28-inch. and also to obser a star with the transit-circle. The party spent about two hou in the observatory.

It seems hardly worth while to call attention to the parti eclipse of the Sun which will take place on August 20, as it w be visible only in Russia and Western Asia. The total eclipse the Moon on Sept. 3 will be scarcely a more interesting phen menon for English observers, for the beginning of totality do not happen until 17$^h$ 6$^m$, and the Moon sets at Greenwich 17$^h$ 18$^m$.

Wolsingham Observatory Circular, No. 42, announces that Red III. type-star, magnitude 8·4, which is not in the Southe Durchmusterung, was detected on July 14 in R.A. 19$^h$ 52$^m$·4, De $-2^\circ \cdot 11'$ (1900), and is probably a new variable; and that Esp 1021 is also probably variable.

Prof. Barnard informs us that he is about to sever his co nection with the Lick Observatory. He has accepted a position the Yerkes Observatory, in connection with the 40-inch telesco His address after 1895, Oct. 1, will be Yerkes Observatory, La Geneva, Wisconsin, U.S.A.

It is announced, but we have had no direct information of t fact, that Mr. R. L. J. Ellery, F.R.S., the Government Astronon in Victoria, has retired from the post, and that Mr. Barrachi, first assistant, succeeds him as Director of the Observatory.

Herr Knorre has published, in the Ast. Nach. 3300, his doub star measures made in 1892–3–4 with the Wellman double-ima micrometer on the 9-inch refractor of the Königlichen Sternwa zu Berlin. The 54 stars are those usually measured.

Professor Daniel Kirkwood, formerly of Indiana Universi U.S.A., died at his home in California on 1895 June 11. hope to give some account of his astronomical work in our n number.

Dr. Hermann Struve gives, in Ast. Nach. 3302, an investigation of the oblateness of Mars from a consideration of the motion of the node and apse of the orbit of the satellites. He deduces an oblateness of $\frac{1}{190}$.

Plans are being discussed and matters are proceeding in connection with the new Observatory at Perth, West Australia. Mr. Cooke, of Adelaide, is spoken of as a likely candidate for the Directorship.

At the Exhibition at the Imperial Institute in connection with the Geographical Congress now proceeding, Harrison's chronometer and other objects of interest from Greenwich are on view.

---

## From an Oxford Note-Book.

Seldom have I had a more delightful surprise, of a mathematical kind, than was afforded me by the sight of a short paper on "The Cœlostat" by G. Lippmann, in the 'Comptes Rendus' for 13 May, 1895. My attention was directed to it by Mr. Johnstone Stoney, who remarks that the proposed instrument is just the thing for eclipse work; and so it is, but it is difficult to see where the possible uses of it end. It ought to replace the equatorial in very many ways. It consists simply of a plane mirror rotating once in 48 hours *about an axis in its plane which is placed parallel to the polar axis of the Earth.* The image of the sky seen by reflection in such a mirror remains fixed in space. A beautiful geometrical proof of this theorem is given in the paper (see page 301), but the fact may be roughly apprehended from the consideration that the reflected ray travels twice as fast as the mirror. But how in the world has so simple and important an instrument been so long overlooked! A telescope may be fixed, pointing to this mirror, in any position, and its field of view will not alter, except for change of refraction &c. There is no rotation of the field, as in many forms of heliostat—it remains absolutely the same. By starting the rotation of the mirror in different positions, different parts of the same zone in declination may be followed; but to get to another zone the telescope must be moved. This seems to limit the applications of the instrument to cases where work is to be done in or near a fixed zone, or on an object like a planet; and the circumpolar regions are awkward to manage, since the reflection is there nearly at a grazing incidence; though probably a second mirror can be introduced in some way with advantage. But the idea is of fundamental importance.

Thinking over the proper place for the second mirror, I think it should be a simple polar heliostat; that is a mirror which can be placed at any angle to the polar axis, and rotated round it once in 24 hours. The function of such a mirror is to leave the sky fixed in space, *but to put the pole in another part of the sky.* Thus, if the mirror be inclined at 45°, some point on the equator, say Orion, is reflected (up or down) the polar axis and becomes the new centre of rotation, while the pole star goes onto the new equator. We have thus substituted for the actual sky another sky rotating with reference to the Earth round Orion: and if we apply to this image the Cœlostat, it is Orion which now has the disabilities previously attaching to Polaris, while Polaris can now be reflected at a comfortable angle. If we can put up with these two reflections, then we have a Cœlostat which will do practically anything. M. Lippmann has done a fine day's work!

---

Some week or two ago I had the most enjoyable experience of seeing at work the new photographic telescope with objective prism which Sir Howard Grubb has just completed for Mr. Frank McClean at Tunbridge Wells. This powerful instrument (12-inch aperture, and $11\frac{1}{4}$ feet focal length, with objective prism of 20°) is being used by Mr. McClean to photograph the spectra of stars, the length of the spectrum being in N.P.D., and the breadth obtained by a slow drift in R.A., according to the method already familiar; and some spectra of great beauty have been already obtained. It is not for me to say more, for my experience of such work is of the slightest. But there was a certain point of quite general interest which presented itself. The spectra were striped with the most perfect regularity in the direction of their length, and a little examination showed that each stripe corresponded to a revolution of the driving-screw. I must confess to considerable astonishment at such apparently large systematic errors in a screw turned out by Sir Howard Grubb; but Mr. McClean remarked that the imperfections need not be large, and for ordinary work would not be sensible. The width of the photographic trace per revolution corresponds to the *difference* between the rotation of the telescope and the rotation of the Earth per revolution of worm-screw. During an exposure near the equator of 20 minutes (equivalent to 40 revolutions of worm-screw) the trace is about $60''$ wide, giving $1\frac{1}{2}''$ per revolution, and on this $1\frac{1}{2}''$ the whole inequality per revolution takes effect; and hence a minute inequality of say $0''\cdot5$ in the driving-screw would stripe the spectrum boldly. It is not to be expected that the best driving-screw should be free from errors of this kind, unless specially demanded. On returning to Oxford, I found by a few series of observations with the verniers that there were systematic errors in the driving-screw of the Oxford Equatorial (also by Grubb) as follows:—

One revolution corresponds to $90^{s}$, and the errors at $0^{s}$, $15^{s}$, $30^{s}$, $45^{s}$, $60^{s}$, $75^{s}$ were respectively $-0^{s}\cdot2$, $-0^{s}\cdot2$, $-0^{s}\cdot1$, $0^{s}\cdot0$, $+0^{s}\cdot3$, $+0^{s}\cdot2$. It is probable that there are such minute errors in all screws.

I do not know whether this powerful method of testing a driving-screw has been remarked upon before. It is certainly new to me.

---

"A POINT," wrote the worried schoolboy, "is that which has no parts, even if you get a magnifying-glass." Mr. H. G. Wells has written a delightful fantasy dealing with the similar deficiencies of solid bodies, which, according to the hero of his book *, have no existence unless extended in the fourth dimension, namely Time. The hero accordingly invents a machine to do for the solid body what the magnifying-glass fails to do for the point—extend it in another dimension. On his Time machine he makes a wonderful journey into the future and finds mankind wofully decadent in two very different directions. We could wish the author had made a more cheerful or pleasant forecast, but the book is thoroughly interesting and amusing, distinctly above the average of such fanciful works. There is a good scene where the first small model of the machine is despatched on its Time journey. "It was the Psychologist himself who sent forth the model Time Machine on its interminable voyage. We all saw the lever turn. I am absolutely certain there was no trickery. There was a breath of wind, and the lamp-flame jumped. One of the candles on the mantel was blown out, and the little machine suddenly swung round, became indistinct, was seen as a ghost for a second perhaps, as an eddy of faintly glittering brass and ivory: and it was gone—vanished! Save for the lamp the table was bare. Everyone was silent for a minute. Then Filby said he was damned. The Psychologist recovered from his stupor, and suddenly looked under the table. At that the Time Traveller laughed cheerfully."

FLYING-MACHINES have not perhaps very much to do with Astronomy, but an apology for mentioning them here might well be built on Terence's '*Nihil humani a me alienum.*' Moreover a distinguished scientific company of some 30 persons, which assembled on Friday, July 5, at Bexley Park, to see some experiments with Mr. Maxim's machine, included the Astronomer Royal and his Chief Assistant, the President of the R.A.S. and his Secretary, and several other gentlemen well known in the astronomical world. The machine in its present form consists of a car driven along rails by the rotation of a pair of screw-fans, and provided with aeroplanes of canvas. When a certain speed is attained these aeroplanes lift the machine; they do not carry it bodily into the air as yet; it is at present sufficient to show that the lifting power is there, and this is clearly demonstrated, firstly, by a pressure indicator, and, secondly, by the rising of a pair of wheels connected with the car against upper rails a couple of feet from the ground. Some months ago the lifting power had been demonstrated more clearly still by the breaking of one of these upper rails, and the releasing of the machine, which then actually flew for some yards; what might have occurred if Mr. Maxim had not at once shut off steam will of course never be know but he was not yet ready to investigate this one of the or six problems which must be solved before flying can be d satisfactorily. In due time he will doubtless proceed to consideration of the remaining problems; at present he claims have shown that it is possible to construct an engine power enough to lift itself and more. The engine is a beautiful exam of Mr. Maxim's great mechanical skill. The whole apparatus of course, made as light as possible. Seen at a little distance, wl running, the machine, with its wide-spreading aeroplanes, certai gives the impression of a great white bird running along to speed up to fly with. There was no doubt about the inter felt by all present, who owe to Mr. Maxim and his part Mr. Brodrick Cloeté, the pleasantest recollections of a m enjoyable afternoon.

---

* 'The Time Machine,' by H. G. Wells. London: William Heinemann. Price 1s. 6*d*.

Looking over a railway bookstall, a familiar picture caught eye in an unexpected corner. On the front page of the 'Sport Times' for July 20 appears a rough sketch of the top of Gre wich Observatory over the following spasm of poetry :—

> The poll appears ;
> For twenty years
> It tells the same old story :
> Do what they will,
> At Greenwich still
> You can observ-a-Tory.

There is also another astronomical allusion on the same page a more ambitious poem entitled " What has become of the Rad which finishes thus :—

> Now, my Lord Rosse, you will help us, no doubt,
> While we are seeking lost Radical lads :
> Lend us your telescope till we find out
> What in the world has become of the Rads.

It is worth remarking that the fame of the big telescop undimmed in lustre, however unkind years may have been to mirror.

Curiously enough, in the paper called 'Pick-me-up' for the sa date (July 20), there is another reference to the same telesc though the writer apparently confuses Lord Rosse with optician Ross. He remarks :—" It appears to have been a d sort of song, for Lucy assured the party she was addressing t it went with her always ; and on dull days she could see shining stars through the gloomy clouds on account of that so If the Astronomer Royal doesn't act on this tip and buy the wo and music before there's a better offer going, he's losing a char A song like this would, it seems to me, give the Ross telesc several points and then come out ahead at the finish."

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

No. 231. SEPTEMBER. 1895.

### *Some Astronomical Records in ancient Chinese Books**.

Astronomy is one of the most ancient, as it is one of the most interesting of the Sciences. It dates its birth from the beginning of the human race. All was new to primeval man. Nature, unclothed as yet in scientific names or formulæ, was to him living and real. To his young fresh intellect, what an interesting field for speculation lay in the blue vault with its countless luminaries, its varied and brilliant constellations as they revolved in everlasting harmony around him. He gazed with admiration on the glorious orb of day, as he ran his daily course, and heard the hissing of the waters, as he plunged into the western seas. On clear starlight nights, he fancied he heard the far off "music of the spheres," a melody too elevated to be heard by mortal ears.

Notwithstanding all these flights of imagination, when history opens, no small progress had already been made in astronomy. In China, the stars had been already named, the seasons determined by means of culminating stars, and a fair approximation made to the length of the year. The zodiac had been divided into 28 constellations and the places of the Sun and Moon determined by their position among the stars. As regards the Sun, at least, this implies no small skill in the art of observing, as the stars are not visible in the daytime. While the Chinese showed such an aptitude for observation, they displayed a remarkable deficiency in the power of generalization and in drawing the legitimate deductions from the data collected. Thus, while the Chinese determined the equinoxes and solstices by means of culminating stars and so determined the position of the Sun,--though they must have perceived that his position at these epochs was slowly changing—yet it was the fourth century after Christ ere they discovered the precession of the equinoxes, *i. e.* about 500 years after it had been discovered by Hipparchus. The name given to the pole star in different dynasties brings out this point more clearly. Thus, at the time of the emperor Yao, about 2300 B.C. the pole star was 10 Draco. Later on, about the beginning of the Chou dynasty, the pole star was β Ursæ Minoris. The name in both cases denotes the Emperor, clearly showing that these names were given to those two stars at those early dates. No reference, however, is made to the change in ancient Chinese history. A blind reverence for the past, inducing an implicit belief in their ancient records, has prevented the Chinese from making any material advance in astronomy, as well as in any other science.

---

* We are permitted by Prof. Russell to reprint his interesting article on Chinese Astronomy, which was originally published in the Proceedings of the Pekin Oriental Society.—[Eds.]

The earliest references to astronomy in Chinese literature are found in the 'Shu Ching.' In the opening chapter are contained the directions of the emperor Yao to his four astronomers, how to observe the solstices and equinoxes. He commanded the second brother Hsi, going east, to reside at the "Bright Valley," so as respectfully to receive the rising Sun, adding that the day is of the medium length and the star Niao. According to Chinese commentators, Niao, which is not the name of a star but of a group of constellations, here corresponds to α Hydræ. It should therefore have culminated about half an hour after sunset. The R.A. of Hydra, 2350 B.C., was 87° 38′. At 6.30 P.M., the earliest hour we can take for the observation, the star would have been about 10° past the meridian.

The emperor then commanded the third brother Hsi to go south and respectfully observe the limit of the shadow. Midsummer would be determined by the culmination of Huo[3], which corresponds to π Scorpii. At the time of Yao, the R.A. of π Scorpii was 180° 39′. At the earliest, the observation could not have been made before 7 P.M., when the star would have already been 14° past the meridian.

The emperor again directed the second brother Ho to reside in the west and respectfully attend the setting Sun. By the culmination of a certain star he was to determine mid-autumn. This star corresponds to β Aquarius, and its R.A. at the time of Yao was 263° 14′. Taking 6.30 P.M. as the time of observation, this star would, at that epoch, have been 14° past the meridian. Lastly, the emperor directed the third brother Ho to go north, and by means of the star Mao to determine the winter solstice. This star corresponds to η Tauri. Taking the time of observation as 5.15 P.M., at the time of Yao it would have been 6° E. of the meridian. With the exception therefore of the winter solstice, the directions to determine the summer solstice and the two equinoxes would have been much more suitable several centuries later on. Evidently, however, the above directions were only intended roughly to indicate the seasons for the purpose of husbandry, and are of no use at all in fixing the date of Yao's

n. The hours at which the observations were made are not tioned; besides, the precession of the equinoxes is so slow as leave the uncertainty within very large limits. It will be resting here, however, to compare these directions of Yao to four astronomers with the 'Hsia Hsiao Cheng,' the calendar of Hsia dynasty, and with the 'Yueh Ling,' attributed by some mentators to the Chou dynasty, by others to the Ch'in dynasty. 'Hsia Hsiao Cheng' is fragmentary, but the parts that remain w clearly that the directions contained in it are practically the e as those contained in the 'Shu Ching.' Thus, for example, he 'Hsia Hsiao Cheng,' it is stated that in the fifth month corpii is central at the beginning of dusk. Now, this is exactly t Yao told his astronomer Hsi.

he 'Yueh Ling' is a complete calendar for every month. It however, extremely vague, neither the day nor the hour of ervation being stated. For example, it says: in the first month Sun is in Ying$^2$ Shih$^1$; whether this means that, at the Chieh Li Ch'un or Yü$^3$ Shun$^3$, or on the first day of the month, the n is in Ying$^2$ Shih, it is impossible to determine. The com- ntators of the 'Chin Ying Li Chi$^4$' say that these observations er to the beginning of the month. I think this view is very bably correct, and that the directions in the 'Yueh Ling' were ly intended roughly to indicate the several months.

We meet with no further astronomical allusions in the 'Shu ing' until the reign of Chung K'ang, the fourth emperor of the ia dynasty. In his reign, probably the first year of his reign, urred an eclipse of the Sun, the most celebrated on record — ebrated not only for its antiquity, more remote by about o years than any recorded by any other nation, but also for dread fate of the two astronomers Hsi and Ho, who were en by surprise and unprepared, at its occurrence, to perform customary rites. These rites were the shooting of arrows, ting of drums, gongs, &c., with the object of delivering the Sun m the monster that was devouring it. The astronomers Hsi l Ho, by virtue of their office, should have superintended these es. They were, however, drunk and incapable of performing ir duties, so that great confusion ensued. On this account, ording to the narrative in the 'Shu Ching,' they were put to th. Our sympathy with them on their rather severe punish- nt will be heightened when we learn that the eclipse in question s only a partial one.

S. M. Russell.

[To be continued.]

---

## *Bright Meteor of July* 7, 1895.

Sunday night, July 7, at about $10^h$ $49^m$, a fine meteor with a uble nucleus was observed from various parts of the country. e following are some of the descriptions :—

Mr. F. W. Dyson, of Greenwich, observed it from a position nearly surrounded by trees and buildings. The time was between $10^h\ 49^m$ and $10^h\ 50^m$. The disappearance occurred at a point 6° further from the pole star than β Ursæ Majoris, after an observed flight of 8° or 10° in about 5 seconds. Its direction of motion was only a little to the N. of the parallel of declination. The nucleus appeared to become double while he was watching it.

Mr. E. T. Campbell, of Woodford, Surrey, gives the time as $10^h\ 51^m$, and says the meteor was double-headed, the interval separating the two parts being ¼°. It travelled slowly, tandem fashion, thus ✱✱—→, in a horizontal direction along 10° or 12° and ended 4° or 5° W. of the last star in the tail of Ursa Major. He further says it was about 2nd mag. or brighter, and lasted 5 seconds.

Mr. W. P. Butler, writing to 'Nature' (No. 1342, p. 369) from the Royal College of Science, says the time was $10^h\ 45^m$, and that the meteor was double, the two components being about ¼° apart travelling together, the smaller one ahead. Their combined magnitude was probably equal to Venus as seen earlier the same evening. He gives the observed path as 19° +20° to 172°½ +35° across Coma Berenices to the S.E. region of Ursa Major.

Mr. L. Demengel, of Sunbury-on-Thames, writing to the 'English Mechanic' (No. 1581, p. 458), mentions the time as $10^h\ 50^m$, and says the meteor was a brilliant one, followed by a trail of 10° in length and 5′ in width. After traversing three-quarters of its course it divided into two portions, both following in the same trail and with very distinct nuclei. Its motion was slow, in a horizontal direction. Length of path about 20°, duration of flight 12 seconds. It started from a point at about 180° +45°.

Mr. G. Charsley, of Beaconsfield, Berks, says the meteor lit up all objects like a Roman candle. It was first seen near Arcturus, and it passed to the N. through the bright stars of Ursa Major. An ember-like piece shot on faster than the ball, which it left behind. It left a yellowish streak on 10° or 12° of its course.

Miss Alice Hodgkinson, writing to the 'English Mechanic' (No. 1585, p. 558), relates that she obtained a good view of the meteor from Ruinworth, near Bolton-le-Moors, Lancashire. It came from the direction of S.W. and travelled across to the S.E., and "divided into two, like sparks from a rocket."

The meteor was also seen at Birmingham, passing from the S.S.W., altitude 25°, to the S.E. altitude 40°. It travelled very slowly, and increased in size until it exceeded the apparent brightness of Venus.

On comparing the various observations the radiant-point of the meteor would appear to be in Libra at about 217° −6°, but the position is liable to considerable uncertainty. The object was seen under circumstances which would be likely to prevent exact observation, for the full moon was shining, and comparatively few stars were visible in the sky by which to mark the path.

ch cases the observer is generally taken unawares, and the whole
parition disappears before he has time to note its position or
·ection of flight accurately.

The meteor seems to have begun when over Bath, at a height of
miles, and to have ended near Buckingham, at an elevation of
miles. The real length of path was about 79 miles, and earth-
int in Norfolk. Two of the observers, who only witnessed about
lf of the path, estimated the duration as 5 seconds, while
·. Demengel, who probably saw the whole, gives it as 12 seconds.
we adopt 10 seconds as a fair average, the velocity would be
niles per second.

The radiant in Libra does not correspond with that of any
own meteor-shower in July. Earlier in the year there are many
liants clustered in this part of the heavens. On April 21, 1889,
1–2 mag. meteor was seen by Prof. Herschel at Slough, and by
e writer at Bristol, which had a radiant at 218° —5°. The fire-
ll of May 29, 1889, $10^h 44^m$ emanated from 215° —7°, while that
May 12, 1878, $8^h 53^m$, showed a radiant at 214° —7°. From 13
·ge meteors registered between April 19 and May 5, I derived
radiant at 210° —9°. There are, in fact, showers of Lybrids
terspersed with fireballs during the whole of the first half of the
ar.

One peculiarity of the meteor of July 7 last was that the
icleus divided into two portions. This is by no means a rare
ature. The detonating fireball of Jan. 25, 1894, had a double
icleus. On Sept. 25, 1889, I saw a bright slow-moving meteor,
nich became fainter at the end of its flight, and the head sepa-
ted itself into two distinct parts. On Sept. 7, 1888, I observed
meteor as bright as Venus travelling with extreme slowness
rough Ursa Major. Just before disappearance two luminous
agments became detached from the nucleus and followed in the
me track as the latter, though losing ground on it. In some
ses I have noticed that the head of a meteor suffers disruption
such a degree just before extinction, that it assumes a beaded
·pearance. In the case of the duple-headed meteor of July 7,
e interval separating the particles was equal to about one-third
a mile; but it is unfortunate that the path of this interesting
ject is rendered doubtful by the want of greater consistency in
e observations on which it is based.

The phenomenon supplies another instance of a fine meteor
·ertaking the earth from an apparent radiant near the horizon.

Mr. W. H. Wood, of Birmingham, has computed the real course
the meteor from observations at Sunbury, Beaconsfield, and
rmingham, and gives the heights as from 50 to 42 miles over
ridgwater and Buckingham respectively. He finds the radiant
210° —10°. The differences in our results are such as must
ise from the independent treatment of observations which dis-
gree amongst themselves.

Bristol, 1895, August 19. W. F. DENNING.

## *The Determination of Right Ascension and Declination from* [illegible] *Standard Coordinates.*

In a paper in the 'Monthly Notices' of the R. A. S., 1893 Nov. [illegible] and in later papers, Professor Turner has pointed out the value of using "Standard Coordinates" in the reduction of plates for the Photographic Chart of the Heavens. These are what would be the rectangular coordinates of the stars as projected on a photographic plate, if the plate had no errors of centering, orientation, &c., and the positions of the stars were unaffected by refraction, aberration, &c. Professor Turner has given a simple method of obtaining these standard coordinates. When they are found they are what may be fairly called *places* of stars; no further reference to the plate is necessary, and if Right Ascensions and Declinations of the stars are required it is only a question of a geometrical transformation.

Let $\alpha$ and $p$ be the R.A. and N.P.D. of a star, A and P the R.A. and N.P.D. of the centre of the plate, and $\xi$, $\eta$ the standard coordinates.

The equations giving $\xi$, $\eta$ in terms of $\alpha$ and $p$ are

$$\left.\begin{aligned}\xi &= \frac{\cos q \tan p \sin(\alpha - \mathrm{A})}{\cos(\mathrm{P} - q)} \quad \ldots \quad &(\text{i.})\\ \eta &= \tan(\mathrm{P} - q) \quad \ldots\ldots \quad &(\text{ii.})\\ \text{where} \quad \tan q &= \tan p \cos(\alpha - \mathrm{A}) \quad \ldots\ldots \quad &(\text{iii.})\end{aligned}\right\}$$

It is of interest to solve these equations, and obtain $\alpha - \mathrm{A}$ and $p$ explicitly in terms of $\xi$ and $\eta$.

From (ii.)

$$1 - \eta \cot \mathrm{P} = \frac{\sin q}{\sin \mathrm{P} \cos(\mathrm{P} - q)}.$$

Dividing (i.) and using (iii.),

$$\tan(\alpha - \mathrm{A}) = \frac{\xi \operatorname{cosec} \mathrm{P}}{1 - \eta \cot \mathrm{P}} \quad \ldots\ldots \quad (\text{iv.})$$

This equation gives $\alpha - \mathrm{A}$ in terms of $\xi$ and $\eta$; $\xi$ and $\eta$ being expressed in circular measure. If the interval between consecutive réseau lines (5′) be taken as the unit, the equation is

$$\tan(\alpha - \mathrm{A}) = \xi \frac{\sec \mathrm{P}}{\frac{2160}{\pi} \tan \mathrm{P} - \eta}.$$

The value of $\log \dfrac{\sec \mathrm{P}}{\frac{2160}{\pi} \tan \mathrm{P} - \eta}$ may easily be tabulated for each zone; and then to obtain $\log \tan(\alpha - \mathrm{A})$ it will only be necessary to look out in this table the number corresponding to argument $\eta$, add this to log $\xi$, and take the value of $\alpha - \mathrm{A}$ from tables of log tangents.

To find $p$, we have from (iii.)

$$\tan p = \sec(\alpha - \mathrm{A}) \cdot \tan q.$$

Therefore

$$p = q + \frac{\sec(\alpha - \mathrm{A}) - 1}{\sec(\alpha - \mathrm{A}) + 1} \sin 2q + \tfrac{1}{2}\left(\frac{\sec(\alpha - \mathrm{A}) - 1}{\sec(\alpha - \mathrm{A}) + 1}\right) \sin 4q + \&c.$$

Also

$$\frac{\sec(\alpha - \mathrm{A}) - 1}{\sec(\alpha - \mathrm{A}) + 1} = \tfrac{1}{4}\tan^2(\alpha - \mathrm{A}) - \tfrac{1}{8}\tan^4(\alpha - \mathrm{A}) - \&c.$$

$$= \tfrac{1}{4}\xi^2 \operatorname{cosec}^2 \mathrm{P} + \tfrac{1}{2}\xi^2\eta \frac{\cos \mathrm{P}}{\sin^3 \mathrm{P}} + \&c. \text{ from (iv.).}$$

Again,

$$\mathrm{P} - q = \tan^{-1}\eta$$

$$= \eta - \frac{\eta^3}{3} + \&c.$$

Therefore

$$q = \mathrm{P} - \eta + \frac{\eta^3}{3} - \&c.$$

and

$$\sin 2q = \sin 2\mathrm{P} - 2\eta \cos 2\mathrm{P} - \&c.$$

Substituting these in the above expansion for $p$, we find

$$p = \mathrm{P} - \eta + \tfrac{1}{2}\xi^2 \cot \mathrm{P} + \frac{\eta^3}{3} + \tfrac{1}{2}\xi^2\eta \operatorname{cosec}^2 \mathrm{P} + \&c. \quad . \quad . \quad \text{(v.)}$$

The value of $\frac{1}{2}\xi^2 \cot \mathrm{P}$ may be tabulated for each zone for different values of $\xi$, and the remaining terms can be given in a small diagram; they will not amount to more than one or two seconds unless the plate is very near the Pole.

The geometrical meaning of the formulæ

$$\left.\begin{aligned} \tan(\alpha - \mathrm{A}) &= \frac{\xi \operatorname{cosec} \mathrm{P}}{1 - \eta \cot \mathrm{P}} \\ \text{and} \quad p &= \mathrm{P} - \eta + \tfrac{1}{2}\xi^2 \cot \mathrm{P} + \frac{\eta^3}{3} + \tfrac{1}{2}\xi^2\eta \operatorname{cosec}^2 \mathrm{P} + \&c. \end{aligned}\right\}$$

is somewhat interesting.

The first formula expresses the fact that great circles through the poles project on a photographic plate into concurrent straight lines. In the second formula $\frac{1}{2}\xi^2 \cot \mathrm{P}$ is approximately the correction for curvature of the projection of a circle of declination on the plate.

F. W. Dyson.

## *The Longitude of Madras.*

It was briefly announced in these pages some months ago that an redetermination of the arc of longitude Greenwich–Madras was in progress. It may not be uninteresting to collect here the results of previous determinations, and to mention the circumstances which have lead to the present operations.

The importance to geodesy of an accurate knowledge of the coordinates of Madras referred to Greenwich is obvious, being, as it is, a zero-point for surveys of the continent of Asia. Mr. Goldingham, the first Director of the Madras Observatory, evidently realized this importance, for he devoted much time to observations of the eclipses of Jupiter's satellites and of the Moon for the purpose of finding his longitude. He published in the Phil. Trans. for 1822 a discussion of a large number of observations of satellites made between 1787 and 1816, which it would be tedious to follow in detail, but it may suffice to say that he did not rely entirely the tables of the satellites, but in the discussion used observations of the same phenomena made simultaneously in England, and that the mean result found for the longitude was $5^{h}\ 21^{m}\ 9^{s}{\cdot}4$ East of Greenwich. It may be mentioned in passing, as a sort of gauge of the accordance of individual results, that any observation which gave a value of the longitude differing more than 30 seconds of time from the mean of similar results was rejected, but all results within this limit were retained. A further series of observations of satellites made between 1817 and 1826 gave an almost identical result ('R. A. S. Monthly Notices,' vol. i.). Mr. Goldingham says "this agreement cannot but be regarded as accidental." The result of 800 lunar observations made between 1787 and 1822 gave a value for the longitude $11^{s}{\cdot}7$ (2′ 55″·5 greater than that from satellites. But the value $5^{h}\ 21^{m}\ 9^{s}{\cdot}4$ E (80° 17′ 21″) was adopted by the Director as the longitude of th Madras Observatory, and by the Indian Trigonometrical Survey then in the early years of its work.

Mr. T. G. Taylor, the successor of Mr. Goldingham, continu these observations of Jupiter's satellites and of the Moon, and f several years published in the Madras volumes the correction the longitude deduced from comparison of these with simi Greenwich observations. The value $5^{h}\ 21^{m}\ 3^{s}{\cdot}77$ found by h from observations in the years 1831–33 was given in the 'Nautic Almanac' from 1834 to 1861. A discussion made by Mr. Edwa Riddle, and published in the 'Memoirs of the R. A. S.' vol. xii., the lunar observations at Madras, and at Greenwich, Cambridg and Edinburgh, in the years 1834 to 1837, gave as results fr comparison with the observations at the three last-named pla respectively, $5^{h}\ 20^{m}\ 54^{s}{\cdot}9$, $5^{h}\ 20^{m}\ 53^{s}{\cdot}9$, $5^{h}\ 20^{m}\ 55^{s}{\cdot}7$, and a furt investigation by Mr. Taylor from the whole series of observat of the Moon from 1831–44 gave the value $5^{h}\ 20^{m}\ 57^{s}{\cdot}28$. last was evidently considered final, for the time at least

$5^h\ 20^m\ 57^s{\cdot}3$ was adopted in the 'Nautical Almanac' on the authority of Capt. Jacob, who succeeded Mr. Taylor, for the years 1862 to 1881, and this appears to be the last determination before the era of telegraphy.

At the time of the Transit of Venus of 1874, one of the British observing stations was in the Mokattam Hills, near Cairo; and as it was necessary to determine the longitude of this station, telegraphic communication was made with Greenwich through Alexandria for this purpose. The line was continued to Suez, and the longitude of this latter place also determined. This forms one link of the first telegraphic determination of the longitude of Madras. The other links were supplied by officers of the Indian Survey, who measured the arcs, Suez–Aden–Bombay, Bombay being connected with Madras by the ordinary operations of the Survey. The complete arc of longitude (Greenwich–Madras) thus measured came out as $5^h\ 20^m\ 59^s{\cdot}42$; and this value has been given in the 'Nautical Almanac' from 1882 to the present date.

About the same time a value was found by another telegraphic chain. A German Transit of Venus party was at Ispahan, and telegraphic connection was made from that place westward to Berlin and eastward to Kurrachee, which was connected direct with Madras. The details of the easterly arcs are not accessible, but the resulting complete longitude appears to be $5^h\ 20^m\ 59^s{\cdot}67$, which is sufficiently accordant with the value given above. Excepting for some subsidiary arcs, which help to establish the longitude of Aden, these were the only telegraphic determinations until quite recently.

As stated above, the Indian Trigonometrical Survey adopted Goldingham's value *, $5^h\ 21^m\ 9^s{\cdot}4$, and this has been retained to the present day; the fact that there are more recent and probably more accurate determinations naturally being noted. The alteration of the numeration of the meridians in successive volumes of a work like the Survey, with every fresh determination, would be inexpedient and troublesome; and when the Survey was confined to India alone, an erroneous numeration of the zero was not important, the error being duly noted; but as the Survey extends its operations to Persia, and there meets the surveying systems of other nations, it becomes a matter for consideration whether the time has not come to make an alteration in the Indian maps. This question was brought somewhat to the front after the International Geographical Congress at Berne in 1891, where the unification of meridians was considered, and where it was suggested to make an international map of the whole world, on the scale of one-millionth of that of nature. The delegate sent by the Indian Government, in making his report, brought it to the notice of the authorities that the longitudes of the Indian Survey Maps were about 2½ minutes of arc in error according to the latest determinations.

---

* This value is sometimes quoted as Lieut. Warren's (Warren was in charge of the Madras Observatory for some years in Goldingham's absence).

This may be said to have led to the work now proceeding. Whether the numeration of the longitude of Madras, or rather of Kalianpur, which is the zero of the Survey, is to be altered in subsequent maps or not, before discussing the question, the obvious course is to determine, if possible, a final value, to know how much the alteration would have to be. The determination *viâ* Alexandria, Suez, and Aden appears to be trustworthy, but it would be injudicious to consider this as final without strong corroboration. The new line has been chosen to go through Persia, as this country now comes within the limit of operations of the Survey, the chain of arcs being Madras–Kurrachee–Teheran–Potsdam–Greenwich. The arc Teheran to Bushire on the Persian Gulf will also be determined, and the arc Bushire to Greenwich may possibly be determined by direct telegraphic communication as a means of check on the whole work, so that, remembering the known skill and experience of the observers, there is every prospect of a result that may be relied on. H. P. H.

## *The Latitude-Variation Tide**.

Shortly after the announcement of the 427-day period of revolution of the Earth's axes of figure and rotation, the ingenious suggestion was made by Prof. Newcomb that, if such a phenomenon existed, it should cause a synchronous oscillation in the mean sea-level, which might be detected by a careful study of the tidal observations of the U.S. Coast Survey. Acting upon this suggestion the Superintendent of the Survey authorized Dr. A. S. Christie, the head of its Tidal Division, to make such an examination. Dr. Christie accordingly chose the observations made at two mareograph stations near San Francisco, Cal., and in February 1892 he communicated his results in an official report. He found, from a 35-years' series extending from 1856 to 1891, a tide with a period of 437·4 days, and a semi-amplitude of 17·3 millim. These results were communicated to the National Academy at Washington, April 1892, in elaborate detail, and excited the liveliest interest among the astronomical members there present. Immediately thereafter, Dr. Christie undertook the reduction of the Coast Survey tidal observations in Penobscot Bay, Maine, extending from 1870 to 1888, and found, similarly, a tide with a period of 424·9 days, and a semi-amplitude of 12·5 millim. These results, together with those which he had previously announced with regard to the Pacific coast tide, he communicated to the

---

* From 'Astronomical Journal,' No. 351.

Philosophical Society of Washington, May 21, 1892. The epochs of maxima and minima at both stations were entirely harmonious, and the combination of the two series gave a mean period of 431±4 days, and a mean semi-amplitude of 15 millim., or 0·59 inches.

These results of Dr. Christie's, it will be seen, are in quite satisfactory accord with those published two years later by Prof. Van de Sande Bakhuyzen*, based on the tidal observations at Helder, near Amsterdam, 1855–1892. The agreement is all the more satisfactory because Prof. Bakhuyzen appears to have been unaware that his researches had been so long anticipated by those of Dr. Christie.

The phase-epochs from these tidal investigations show a most remarkable accord with those derived from astronomical observation upon latitudes. If the variation of sea-level is caused by the divergence of the Earth's axes of rotation and figure, low tide at any station must occur when the pole of rotation lies between the pole of figure and the station, *i. e.*, at the time of maximum latitude at that station. Now the Julian date at low tide at Greenwich, according to these investigations, would be

| | |
|---|---|
| San Francisco (Christie) ............ | 2 405 137 |
| Helder (Bakhuyzen) ................ | 2 405 185 |
| Mean ...................... | 2 405 161 |

But, by equation (52), 'Astron. Journal,' No. 322, the Greenwich epoch of maximum latitude, for the 428-day term, is 2 405 164. Thus the difference between the results is only three days in this case.

Similarly we have the date of low tide at Greenwich from the observations at

| | |
|---|---|
| Penobscot Bay (Christie) ............ | 2 407 302 |
| While formula (52) gives ............ | 2 407 310 |

where the difference is only eight days.

The range of the tide, as determined by the observations on the Pacific coast, is one and a third inch; that on the west Atlantic shore is one inch; and that on the east shore is two-thirds of an inch. Notwithstanding the natural distrust attaching to investigations so delicate, upon a phenomenon almost evanescent in its character, the harmony between the results of tidal and astronomical observation, as exemplified above in the dates of the principal phases, can hardly be regarded as fortuitous.

S. C. Chandler.

---

* See 'Observatory,' 1895 March.—[Eds.].

## *Selenographical Notes.*

EGEDE.—This small lozenge-shaped enclosure, standing in the bright hilly region separating the Mare Imbrium from the Mare Frigoris, is generally so inconspicuous that it seems hardly to deserve a distinctive name. Its attenuated walls, nowhere exceeding 400 feet in height, have hitherto been shown as perfectly continuous and as surrounding an area devoid of any detail whatever, except a solitary mound on the south-eastern side which is only represented in Neison's Map. Through the favour of Lieut. P. B. Molesworth, R.E., I have, however, a beautiful drawing of this formation, made at Hong Kong, 1892, July 31, 7$^h$ 15$^m$ Local Time, with powers of 150 and 225 on a 9¼-inch reflector, which throws new light on this object, and exhibits very many features which have not been previously recorded. All selenographers represent the low rampart as continuous, Schmidt alone showing two craters on its summit—one on the north and the other on the opposite side. Lieut. Molesworth noted six distinct gaps in the circumvallation—(1) caused by a crater in the south-west wall; (2, 3, and 4) narrow gaps in the north-west wall; (5) a rather wide break in the east wall; (6) a prominent valley traversing the border at the extreme southern corner, and bounded on either side by ridges, extending for some distance towards the south, thus forming a communication between the interior and the country outside. The drawing shows also that the barrier is far from being so straight as represented in the maps, but rather undulating, and by no means uniform in altitude. Though roughly lozenge-shaped, the western and eastern corners are boldly rounded off, the latter especially so. As just mentioned, Neison is the only observer who shows any detail on the floor, and he merely draws one faint object, like a mound, on the south-eastern quarter. Lieut. Molesworth succeeded in detecting five on the date specified, viz., three, close together, near the inner foot of the western wall, another on the south-western side of the interior, a little east of the crater on the wall, and a fifth on the extreme northern side of the floor. All these objects, though minute, are very clearly shown. They appear to be crater-cones. On the floor opposite the mouth of the valley which passes through the south wall is a small isolated hill which casts a sharp black shadow.

Just outside the south-east border he noted a broader and deeper valley, at the bottom of which are two rill valleys, "and in the prolongation of them towards the north-east is another narrow rather irregular cleft of the same nature. To the north are several craters, three in a line. . . . The whole region is broken up into low hillocks, with no very definite 'lie' about them." Lieut. Molesworth shows in all seven craters just outside the north-eastern border; Schmidt draws two only, both of which can be recognized in the drawing of the former. It is not clear that the crater recorded by Schmidt on the south wall answers to that drawn by Molesworth, as the latter draws his object much more to the west. Schmidt, too, has a second crater just outside the border, near that on the wall, and a third some little distance towards the south-west, which is shown in the Hong Kong drawing. The relative positions of these objects seem to render it doubtful if the two craters of Schmidt and Molesworth represent the same features. However this may be, Egede can be no longer regarded as a structureless formation, for not only within its limits but in its vicinity very many noteworthy features have been seen which, though new to selenographers, unquestionably exist. T. Gwyn Elger.

Beaumont House, Shakespeare Road,
Bedford, 1895, Aug. 19.

---

## CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

### *The supposed Comet of* A.D. 945.

Gentlemen,—

I do not suppose the remark at the beginning of my little work on 'Remarkable Comets' is likely to be contested, viz. that it is not easy in many cases, with regard to ancient and mediæval accounts of peculiar appearances in the sky, to decide whether they relate to comets, meteors, new stars, or meteorological phenomena. One of these is described by the ecclesiastical historian, Flodoard, as having been seen in the year A.D. 945, and Pingré considers it to have been a comet on account of the length of time during which it is stated to have been visible. I am not sure, however, that this conclusion necessarily follows, though the appearance in question was certainly not that of a new star.

The historian states that at the time of the death of Theotilon, Bishop of Tours (Mr. Chambers inserts a circumstance which is not to be found either in Flodoard or in Pingré's translation), which occurred suddenly whilst he was on his way from Laon to his own city, "apparuit signum quoddam luminis per æra discurrens, cubitum longitudinis habere visum; cujus lumine ad depellendas noctis tenebras sufficienter perfuncti sunt, qui funus ejus deducebant; talique potiti solamine per milia fere, ceu fertur, ducenta, Turonicam usque corpus ejus perferunt urbem."

This does not read like the description of an eye-witness; though, had a very bright comet appeared in 945, Flodoard (who did not die until 966) would probably have seen it. Pingré says that other authors speak of a comet in that year; but their accounts are suspiciously like that of one reported to have appeared in 939. It is evident that the bearers of the corpse of Theotilon would not need any peculiar source of light during a journey nearly 200 miles at a season of the year when they would ha had daylight much more than half the time. Probably all that meant is that during several successive days, when night came o a peculiar light was seen in the sky. The context shows that t occurrence took place in the month of August; and I wou venture to suggest that the account really refers to a very brig manifestation of the Perseid meteors, particularly as the expressi "per æra discurrens" seems much more applicable to meteo than to cometary motion. The "signum" may well have been succession of luminous appearances; and its length (roughly sta as equal to that of a cubit) may be intended to refer to one of brightest of the meteors.

Yours faithfully,

Blackheath, 1895, Aug. 21.
W. T. LYNN

## *The Total Eclipse of* A.D. 1030.

GENTLEMEN,—

As the central line of the total eclipse of the Sun on 9th of August next year will pass in the early morning a littl the north of Throndhjem, the primacy of Norway, it may b interest to refer to one which was total at the same place on last day of the same month 866 years before. This is one of few probably authentic instances of a total eclipse taking p during a battle; and the first recognition of the fact is due to late Prof. Hansteen of Christiania, who pointed it out in a p published in the Ergänzungsheft of the 'Astronomische N richten' in the year 1849. The battle in question was tha Stiklestad, in which Olaf the Fat (called St. Olaf or St. O after his death) was killed in his attempt to recover the crow Norway, of which he had been dispossessed two years before Knut (Canute), king of England and Denmark; and it adds to interest of the contest to English readers that Harold Hard (Olaf's younger half-brother), who fell at Stamfordbridge 1066, fighting against Harold, our last Saxon king, was pres though very young, and was wounded. Stiklestad was ab thirty miles to the north-east of Throndhjem; and the accoun the battle in the Norwegian Sagas mentions a darkness which have been produced by the eclipse, and, if this be accepted, fi the date as the 31st of August, 1030. Laing, in his translatio the Heimskringla or Sagas of the Norse kings, thus renders account of the darkness:—"The weather was beautiful and Sun shone clear; but when the battle began the heavens and Sun became red, and before the battle ended it became as dar at night"*. And the skald or poet Sigvat (who, however should be remarked, was not present) wrote†:—

---

* Second edition by R. B. Anderson, LL.D., vol. iii. p. 256.

† *Ibid.* p. 259.

"No common wonder in the sky
Fell out that day—the sun on high,
And not a cloud to see around,
Shone not, nor warmed Norway's ground.
The day on which fell out this fight
Was marked by dismal dusky light,
This from the East * I heard the end
Of our great king it did portend."

The eclipse passed over Norway soon after noon. It was annular when it commenced upon the Earth, and it is doubtful whether it was quite total at Stiklestad, as the width of the shadow was very small in that region. Those who repair to the neighbourhood next year will have a better phenomenon to see (the eclipse being certainly total for a short time), and let us trust they will be able to observe it under more peaceful circumstances, though of course its duration will be longer in the northern part of Japan and on the adjacent Asiatic coast.

Yours faithfully,

Blackheath, 1895, July 13. W. T. LYNN.

## *The Periodicity of Jupiter's Markings.*

GENTLEMEN,—

I may perhaps be permitted to supplement Mr. Waugh's letter in the August number of the 'Observatory,' by saying that my attention was first called to the possibly cyclical character of Jupiter's markings by the discovery of the curious old engraving of the planet in Seller's 'Atlas Cœlestis,' concerning which I read a paper before the Royal Astronomical Society in June 1887 ('R. A. S. Monthly Notices,' vol. xlvii. p. 515)—a comparison of this engraving with a drawing of my own made in 1858, with another by the late Mr. Lassell of the same date, which appears on p. 52 of vol. xix. of the 'Monthly Notices,' and with many others of the now famous "red spot," which subsequently appeared, inducing a strong conviction in my mind that this particular region of the planet was probably the seat of the periodical appearance of a notable disturbance in the shape of a spot, sometimes dark and sometimes vividly coloured. My 25 drawings of the planet were selected as typical ones, for comparison with others taken at more or less distant intervals.

The matter is now before the Jupiter Section of the British Astronomical Association; but as there must be many Fellows of the Royal Astronomical Society among your readers who have not yet joined the Association, I would invite such as may be interested in zenography to compare any and all drawings of Jupiter (made at sufficiently distant intervals) to which they may have access, to assist in determining how far the idea of notable markings being cyclical or periodic has any foundation in fact.

Forest Lodge, Maresfield, Uckfield, I am, faithfully yours,
1895, Aug. 12. WILLIAM NOBLE.

---

* The poet may have been in Iceland at the time, and heard the report from the east.

## *The Visibility of the Dark Side of Venus.*

Gentlemen,—

As the planet is now rapidly approaching to inferior conjunction with the Sun, the following notes may perhaps be of interest.

In the 'Report of the British Association for 1873,' pt. i. p. 404, Prof. A. Schaparik, of Prague, has called attention to some early observations of this phenomenon, commencing with some remarks from Dr. Derham in his 'Astro-Theology' (ed. 1726, book v. ch. i.), who, when alluding to the spherical figure of the planets, proceeds to say:—"And this Sphericity, or Rotundity, is manifest in the Moon, yea and in Venus (*b*) too, in whose greatest Falcations the dark part of their Globes may be perceived, exhibiting themselves under the appearance of a dull and rusty color." He then gives the following note:—"(*b*) What I have here affirmed of the *Secondary* light of Venus, I have been called to account for by an ingenious Astronomer of my Acquaintance. But I particularly remember that as I was viewing Venus some years ago with a good 34 foot Glass, when she was in Perigee, and much *horned*, that I could see the darkened part of her Globe as we do that of the Moon, soon after her change. And imagining that in the last total Eclipse of the Sun the same might be discerned, I desired a very curious Observer that was with me, and looked through an excellent Glass, to take notice of it, who affirmed that he saw it very plainly." Prof. Schaparik also remarks: "Arago, who mentions this observation, quotes from a French translation published in 1729. It would be very interesting to know if this observation is found also in the first English translation published in 1714." I have a copy of this 1714 edition, which is really the *second* English translation, and I do not find that the planet Venus is once mentioned therein.

Yours faithfully,

C. Leeson Prince.

The Observatory, Crowborough, Sussex,
1895, Aug. 26.

---

## OBSERVATORIES.

Yale.—Dr. Elkin's concise Report of the work with the heliometer during the year ending May 31 last, tells of the completion of some valuable work which he and Dr. Chase have had in hand, the results of which we look forward to with much interest. He says:—"I have continued and brought to what I hope is a final close the series on the parallaxes of the first-magnitude stars, and hope to present the definitive results in the near future. The series on the parallaxes of the large proper motion stars on which Dr. Chase has been mainly engaged, now comprises 99 stars, all but two of which have been observed at two parallax maximum epochs in general on three nights. It seems desirable, however, e drawing any conclusions from these data, to eliminate the of the proper motion, and we therefore propose to secure urther epochs for each star. In pursuance of this plan nine have already been taken at a third epoch."

e observations and results of the determination of the solar lax from observations of Iris are to be printed with Dr. Gill's ır investigations on Victoria and Sappho. Some emendations been made in this work which slightly reduce the value of the parallax from the Iris series as given in the last report 25).

st year Dr. Elkin described an apparatus which he was having for the photography of meteor-trails. This, which consists ı equatorial mounting carrying several cameras, was finished ne for observation of the August meteors of 1894, and was set tion on three nights, August 9, 10, and 11. It was a little pointing to find only two trails as a result of 11 hours sure. Dr. Elkin does not despair, but hopes to be more ssful this year.

---

IE POONA COLLEGE OF SCIENCE OBSERVATORY.—We seem to heard little of this observatory lately, which is explained by ular recently sent to astronomers by the Director, Prof. K. aegamvala. He reports that, after considerable delay, the vatory is now fairly well equipped. It possesses a Cassegrain tor of 16½ inches aperture and 127 inches focus, adapted for visual and photographic work, and supplied with electric rol; to this is attached a 6-inch achromatic finder, with filar ometer and solar eyepiece. A 12-inch siderostat by Cooke, an 8-inch lens by Grubb, and various spectroscopes and ssories, is reserved for solar spectroscopic work. Besides this is a 3-inch transit, a chronograph, and a sidereal clock.

ıt with this useful equipment Prof. Naegamvala finds himself le to make efficient use of it for the want of time and help. himself, in the first instance, is a teacher, and conducts classes hysics and Astronomy in the College, which, as may be readily rstood, leaves him little time to devote to observations; and . Naegamvala now intends to appeal to the authorities to ve him from his teaching duties that he may spend his energies ractical spectroscopy, and asks for the support of astronomers is course.

---

## PUBLICATIONS.

IE 'ASTRONOMISCHE GESELLSCHAFT' CATALOGUE OF STARS S TO THE NINTH MAGNITUDE.—Zone 25° to 20° N. decl. of large Catalogue, observed and reduced at Berlin under . Becker's direction, has recently appeared, and we take this opportunity of giving an account, for which we are mainly indebted to the 'Vierteljahrsschrift der Astronomische Gesellschaft,' of the progress of this work. Six Observatories have already published their Catalogues. These are:—

| | Zone. | No. of Stars. |
|---|---|---|
| Christiania.......... | 70°–65° N. | 3949 |
| Helsingfors ........ | 65 –55 N. | 14680 |
| Cambridge (Mass.) .. | 55 –50 N. | 8627 |
| Bonn............... | 50 –40 N. | 18457 |
| Berlin ............ | 25 –20 N. | 9209 |
| Albany ............ | 5 – 1 N. | 8241 |

The separate observations are also published by Christiania, Helsingfors, Cambridge (Mass.), and Bonn, but not yet by Berlin and Albany. At Albany several type-written copies have been made, but it is not proposed to publish the separate observations at present.

*Kasan, Zone* 80°–75°.—Dr. Dubiago reported in 1894 July that the Catalogue was complete except for one small correction, and that the copy for press was begun.

*Dorpat, Zone* 75°–70°.—The printing, which has been delayed by the illness of Herr Schwarz, is being proceeded with.

When those two sections are finished, the Catalogue will be complete from 80° to 40°.

*Lund, Zone* 40°-35°.—All the observations (31752 in number) have been made, reduced, and checked, and it is expected that the manuscript of the Catalogue will be ready during this year.

*Leiden, Zone* 35°–30°.—The separate observations are published: the precession and secular variation to bring the observations to the epoch 1875 have been computed. Constant zone-corrections have still to be applied. The Catalogue is being compared with Lalande's and Bessel's; and these catalogues are further being compared with Bradley's, not only between declinations 35° and 30°, but also from 25°–30° and 38°–40°.

*Cambridge, Zone* 30°–28°.—The mean places for 1875, deduced from 49882 separate observations, are entered in a large catalogue for the first $14^h$. The smaller catalogue of final results is ready for press from $0^h$ to $12^h$. The remaining hours are partly prepared for press, and are being rapidly completed.

*Berlin, Zone* 20°–15°.—Dr. Auwers reports, 1894 July, that the precessions and secular variations to 1875 for the 9789 stars which this Catalogue contains have been computed in duplicate. The MS. giving the places of 9789 stars was ready for the press two years ago; but the publication has been delayed till a comprehensive comparison with other catalogues has been made. The places of 2751 stars are given by Lalande, and 7403 by Bessel. Comparison has also been made with the catalogues of D'Agelet, Piazzi, Bossert's supplement to Lalande, Struve, Taylor, Rümker, and others. A thorough determination of the proper motions has been made; wherever the star is not to be found in Bradley or Mayer, but exhibits signs of proper motion, it was reobserved by Dr. Batterman in 1890 and 1891. Out of 821 stars so observed proper motion of 400 was determined. The Catalogue is completed as far as 7$^h$ 53$^m$, and will probably be continued without any interruption. The introduction is, however, hardly begun, so that the Catalogue cannot be published in less than a year (from 1894 July).

*Leipzig, Zones* 15°–10° *and* 10°–5°.—The calculation of precession and secular variation is finished. There is still a systematic error to be cleared up, and a revised list of 700 stars to be observed.

*Nikolajew, Zone* 1° N. *to* 2° S.—The reduction of the observations to the epoch 1875 has been begun. It is likely to be some time before this Catalogue is completed.

---

PUBLICATIONS OF THE POTSDAM ASTROPHYSICAL OBSERVATORY, VOL. X.—Shortly before the death of Prof. Spörer was published the Tenth Volume of the Potsdam Observations, containing the most recently completed section of the work which he initiated and carried on so successfully, the results of the observations of sun-spots made at Potsdam in the years 1885 to 1893. These observations are made chiefly by photography, but not altogether so. If the day does not appear favourable to photography, the Sun's surface is examined visually, and sometimes this is done to verify the existence of small spots which appear doubtful on the photographs. The measures of the photographs, the results of which are given in this volume, were made by Dr. Lohse, the visual observations by Prof. Spörer. The published results are analogous to the Greenwich Sun-spot Ledgers, inasmuch as the positions of a group on all the days of its appearance are collected, and each day's appearance is represented by one line of figures, giving the heliographic latitude and longitude of the mean of the group, but not the areas, as in the Greenwich results. The comparative sizes of the spots are mentioned in the copious notes. Besides the tabular matter, there is an interesting Appendix, giving a short history of the observation of sun-spots and many diagrams, which show at a glance the spots as they appeared during each rotation, and also some showing graphically the distribution in latitude. The sun-spot work at Potsdam will be carried on by Dr. Kempf, who indeed, is responsible for most of the work of this publication, and also for the latter half of the book which contains the meteorological results of the Observatory.

---

ANNALES DE L'OBSERVATOIRE DE NICE.—Volume IV. of the Nice publications contains an investigation by M. Perrotin of the inequalities in the elements of Vesta; a catalogue of nebulæ by M. Javelle; observations of small planets and comets, and meridian observations in the years 1888 and 1889. These latter will be found of special interest, as they are from Struve's Catalogue of Double Stars

# NOTES.

Comet Notes.—A faint comet was discovered by Swift Aug. 20, of which we have received the following elements a ephemeris from Dr. Berberich, calculated from observations Aug. 21, 24, 25.

$$T = 1895, \text{ Sept. } 3{\cdot}3630 \text{ Berlin M.T.}$$

$$\left.\begin{array}{ll} \omega \ldots\ldots & 179^\circ\ 38' \\ ☊ \ldots & 173\ \ \ 0 \\ i \ldots\ldots & \ \ \ 4\ 39 \end{array}\right\} 1895{\cdot}0.$$

$$\log q = 0{\cdot}1654.$$

Ephemeris for Berlin midnight.

| | R.A. | N. Dec. | Brightness. |
|---|---|---|---|
| | h m s | ° ′ | |
| Sept. 2.... | 0 56 3 | 6 15 | 1·15 |
| 6.... | 1 4 3 | 6 18 | 1·17 |
| 10.... | 1 11 28 | 6 16 | 1·18 |
| 14.... | 1 18 16 | 6 10 | 1·18 |
| 18.... | 1 24 23 | 6 0 | 1·16 |
| 22.... | 1 29 49 | 5 47 | 1·13 |

He suggests that the comet may prove to be a periodic one.

The following search ephemerides of Comet 1884 II. (Barna and Faye's Comet are by Berberich and Engström respecti Faye's Comet is at its brightest early in October, but does pass perihelion till March next.

| | Comet 1884 II. | | Faye's Comet. | |
|---|---|---|---|---|
| | R.A. | N. Dec. | R.A. | Dec. |
| | h m | ° ′ | h m | ° ′ |
| Sept. 3 .... | 2 53 | 17 45 | 21 26 | 1 47 N |
| 11 .... | 2 53 | 18 32 | 21 21 | 0 43 N |
| 19 .... | 2 50 | 19 6 | 21 17 | 0 25 S |
| 27 .... | 2 44 | 19 26 | 21 15 | 1 32 S |
| Oct. 5 .... | 2 35 | 19 31 | 21 14 | 2 36 S |

A. C. D.

---

Minor Planet Notes.—Planets BY, CB were discovered Charlois on June 20 and Aug. 23 respectively. The discovery the former should have been announced last month. A. C. D.

---

The Electrical Measurement of Starlight.—For some ti past a new method of measuring the energy possessed by st light has been in process of development by Prof. Minchin. short announcement of this investigation was made in 'Natur of 1894 Jan. 19, since when, by help of a Government grant, important addition has been made to the apparatus, and exper ments have been made, of which a description, with some ear results, was published in 'Nature' for July 11 of this year. The main feature is a photo-electric cell which, so far analogous to the cell of an ordinary electric battery, consists of a metal inserted in liquid. The metal is an aluminium wire tipped with a small plate of selenium prepared by a process which leaves the selenium in a condition most sensitive to light. The aluminium wire thus tipped is inserted in a vessel filled with œnanthol, but in a glass tube, so that the wire is not in contact with the liquid; platinum wires connect respectively the liquid and the aluminium wire to the poles of a quadrant electrometer (Clifton's form), and it is then found that when light falls on the selenium the electrometer shows a change of difference of potential. Roughly speaking, the difference of potential produced by ordinary diffused daylight is something between one-third and half a volt, or if an ordinary paraffin candle be held at a distance of 9 feet from the selenium, an electromotive force of about ·03 volt is produced, and the effect varies inversely as the distance of the candle.

The experiments on stars are being carried on at Mr. W. E. Wilson's observatory at Darramona, Westmeath, where the photo-electric cell has been mounted on the 2-feet reflector in place of the eyepiece, so that the selenium plate is at the focus, and has been used to measure the electromotive forces generated by the light received from Jupiter, Saturn, Vega, Arcturus, Regulus, Procyon, and some other stars. The light of Arcturus was found to give 0·82 of the E.M.F. produced by the candle at 9 feet; the light of Saturn 0·56, which was about the same value as for the light of Regulus.

The cell is sensitive to all the rays of the spectrum, but the maximum effect is produced by the yellow. It is sensitive to rays considerably below the visible red, and to those beyond the blue. It is explained that it is essential that the whole image of the star should fall on the receiving selenium surface, and it is important that the cell should be adjusted so that this surface is just covered by the image. In fact, the integral of the energy which is impressed on the sensitive surface is measured by a function of the observed electromotive force.

In adopting a formula for calculation, the usual photometric formula $m' - m = \frac{10}{4} \log_{10} \frac{B}{B_1}$ has been followed, substituting $E^2$, the square of the E.M.F., for B, the brightness, so that the photo-electric formula is $m' - m = 5 \log_{10} \frac{E}{E_1}$, which gives the difference of magnitude of two stars in terms of the observed electric effect. Substituting some of his measurements in this formula, and assuming the magnitude of Arcturus to be 0·2, Prof. Minchin finds that of Regulus to be 1·33: and taking this value for Regulus, the measures of Regulus and Procyon show this latter star to be of magnitude 0·46. The photometric magnitudes of these stars are respectively 0·2, 1·4, and 0·5, a good agreement between the t[illegible] methods; but Prof. Minchin points out that no such agreeme[illegible] should be expected when two stars of different colours are co[illegible]pared. The only intelligible comparison of two lights consists [illegible] measuring the energies which they radiate per unit time per u[illegible] area at unit distance.

THE ROTATION-PERIOD OF THE SUN.—Some months ago [illegible] mentioned a discussion by M. Stratonoff, of Pulkova, of t[illegible] rotation-period of the Sun as deduced from positions of fac[illegible]. The conclusion arrived at was that the rate of rotation of fa[illegible] varies with the solar latitude, and that the rate was not the s[illegible] as that for the spots in the same latitude. In a recent numbe[illegible] the Ast. Nach. (3287) Dr. Wilsing traverses M. Stratonoff's res[illegible] Dr. Wilsing's opinion, based on his own investigations, is that fac[illegible] rotate at the same rate in all latitudes; and he points out t[illegible] M. Stratonoff's data, treated in a rather different way, sh[illegible] the same result, or, rather, that the apparent variation fro[illegible] constant rotation-period is not more than might be expec[illegible]ed remembering the uncertainty of observed positions of fac[illegible]. He corrects some errors in M. Stratonoff's figures, and the c[illegible]mparison of rotation-periods as determined by different met[illegible]od which we published on p. 133 of this volume, should now stan[illegible]:

| Lat. | Stratonoff. | Spörer. | Dunér. |
|---|---|---|---|
| | Length of solar rotation-period as determined by | | |
| 0° ...... | $24^{d}{\cdot}66$ | $25^{d}{\cdot}09$ | $25^{d}{\cdot}46$ |
| 15 ...... | 25 ·26 | 25 ·44 | 26 ·35 |
| 30 ...... | 25 ·48 | 26 ·53 | 27 ·57 |

MR. HERMAN S. DAVIS, of Columbia College, New York[illegible] completed his investigations of the Rutherford photograph[illegible] η Cassiopeiæ. It will be remembered that a few months sinc[illegible] published the parallax of η Cassiopeiæ as derived from meas[illegible]ments of these photographs. He has now measured 62 [illegible] shown on the plates, and has deduced accurate places for 18[illegible] The mean results being given in two tables—one referrin[illegible] differences between the stars and η Cassiopeiæ, and the o[illegible] giving the whole 63 stars arranged in order of R.A.

THE death is announced of Prof. DANIEL KIRKWOOD, form[illegible] of Bloomington University, Indiana. Prof. Kirkwood wil[illegible] remembered by astronomers for his researches relating to [illegible] smaller celestial bodies, asteroids, comets, and meteors. Whe[illegible] was noticed that in the region of space which contains the or[illegible] of the known minor planets there were *lacunæ* in which non[illegible] these small bodies moved, Prof. Kirkwood pointed out that [illegible] periods of bodies having their orbits in these gaps would be commensurable with that of Jupiter; hence the same relative positions of such bodies and Jupiter would recur, and the disturbing force acting in the same direction time after time would cause the orbits of the small bodies to be perturbed, so that finally they left the region. He advanced a similar theory of commensurability of periods to account for the divisions in Saturn's rings. Prof. Kirkwood wrote much on the subject of comets, and in many cases succeeded in establishing the identity of the same body seen at two apparitions. He was one of the first persons to broach the theory that meteor-streams were caused by the disruption of comets. Among his other writings may be mentioned papers in which he urged the untenability of Laplace's nebular hypothesis, and in which he advanced other views as to the primary cause of the celestial bodies. He died at his home in Riverside, California, on 1895 June 11, in his 81st year. Prof. Holden says of him, "His personal friends will long rememember his kindly, upright, and beautiful character and influence. No one could be with him without knowing that here was a true and a good man."

REPORT OF THE WATSON TRUSTEES *.—THE subject of variable stars was erected into a distinct branch of astronomical science by Argelander, beginning in 1843, and occupied a large share of his activity and interest during a score of years. His classical labours were succeeded or overlapped by those of Schönfeld, who assumed the principal charge of the subject for another score of years, when his devotion to the great work of the Southern Durchmusterung and, later, his failing health left opportunity for other hands to take up and continue the work where they had left it. Since the issue of Schönfeld's Second Catalogue the number of known variables has more than doubled, while the fund of observations pertaining to them has vastly increased. Chandler's work in this direction, besides the incidental work of observation and discovery which he has contributed to it, has involved the collection of all the data in astronomical history, their discussion, and the formulation of the elements of their light-variations into numerical laws. The catalogues of 1888 and 1893, while filling a very moderate number of pages of print, are a crystallization of all the known facts. Especially may be mentioned the investigations of inequalities in the periods of these bodies. While the number of these inequalities known in Schönfeld's time amounted to only about half a dozen, Chandler has detected their existence in about eighty other stars, and has deduced the numerical laws in about fifty of them. This will indicate, in one direction only, how the labour of caring for these objects is increasing.

It would be unjust if, while alluding to these important

---

* Continued from p. 270.

researches, no mention were made of Dr. Chandler's ingenious and successful device of a new form of instrument for making that class of measurements of position which had previously been made by meridian instrument alone. Both the instrument and the method were novel. In the former, instead of a motion of rotation, determined mechanically by the pivots of a horizontal axis, there was substituted one about a vertical axis determined by gravitative action of an instrument resting in mercury.

As to method, instead of a vertical plane passing through the pole, which is the fundamental plane of reference for meridian instruments, there was substituted a horizontal circle. The value possessed by such an entirely different method consists in substituting a totally different sort of observation, and hence a different set of the systematic errors to which all observations are liable, so that the combined results of the two methods are likely to be freer from them than those obtained by an adherence to a single system of observation. In a memoir of 222 pages Dr. Chandler develops the theory of the instrument and method mathematically, and gives the result of its practical use in observations made with it for a year, and directed to various astronomical problems.

Although not mentioned as forming any part of the grounds for the award of this medal, Dr. Chandler's important labours for many years upon cometary orbits are well known to astronomers. Casual mention may be especially made of his computations relative to the principal component of 1889 V., and the action of Jupiter in 1886 upon it, which led to a complete transformation of its orbit; also the definite determination of the relative orbits of the several components into which the comet became separated in consequence of that disturbance.

The Trustees of the Watson Fund feel that this brilliant series of investigations is preeminently deserving of the highest recognition which can be given by the National Academy, and have therefore not hesitated in recommending the award of the medal to Dr. Chandler.

S. NEWCOMB.
B. A. GOULD.
A. HALL.

---

IT is a pleasant feature of this, the holiday season of the year that we often have then the privilege of making the acquaintance of our *confrères* from American and Continental Observatories, who are spending their vacations in visiting observatories foreign to them. Recent visitors to Greenwich include Dr. Konkoly, of the O'Gyalla observatory; Prof. Hoffman, of Baltimore; Prof. J. S. Brown, who has recently been appointed to a high place on the staff of the Washington Observatory, and is spending six months in recruiting his health and at the same time studying the internal arrangements of European observatories; and Dr. H. S. Pritchett, of St. Louis University, son of the Director of the Morrison Observatory, Missouri, U.S. This last-named astronomer is just completing his *year* of absence which it is customary for some American institutions to grant at long intervals to members of their staff, and which is often spent in self-improvement. Dr. Pritchett has spent his year in seeing Pulkova, Nice, Paris, and other observatories, but he has stayed principally in Munich, where he joined the classes under Prof. Seeliger, of whom he speaks with much admiration, and obtained with the highest honours the degree of Ph.D. for a dissertation under the heading "The determination of the diameters at Saturn from observations of the Satellites."

---

Our esteemed correspondent, Mr. C. L. Prince, sends us an amusing extract on the subject of popular notions about Comets. In 'Bell's Weekly Messenger' for Sept. 16, 1811, there was a long article respecting the comet of that year, with a diagram to "show its position with respect to the stars of Ursa Major," and in another column appeared the following paragraph:—"An old lady who lodges at Camden Town was found immersed to the chin in a large water-butt at the back of the house a few mornings since, and on being questioned as to the cause of placing herself in such a situation she said she had been informed by a fortune teller that the world would be destroyed by the comet which was in view, and that she had got into the butt in order that she might dip her head under water while the tail of the comet was passing"! Mr. Prince goes on to relate an experience of his own, when a presumably intelligent person asked him "whether it would be *safer* to be on the sea or on the land" when a certain comet then visible was nearest the earth.

---

Messrs. Horne and Thornthwaite have sent us a copy of the new edition of their 'Hints on Reflecting and Refracting Telescopes." Published as this is by a commercial firm, it might be thought that it is merely a glorified trade catalogue, but, as a matter of fact, the price list occupies very few of the hundred pages of the book. The rest forms quite a little treatise on practical astronomy, with a page or two on the latest branch af the subject, astronomical photography. Methods of adjustments are explained, and there are lists of objects for testing both defining and light-gathering power. The book, which costs one shilling, would be a useful investment for a novice about to set up an observatory.

---

The death is announced of Dr. W. Fabritius, of the Kiew Observatory. Born in 1845 at Wiborg in Finland, he made his first efforts at practical astronomy at the Helsingfors Observatory, where he helped to make the zone observations with the transit-circle during the years 1869 to 1871. From September 1871 to the end of 1873 Fabritius worked at the Bonn Observatory, and in 1874 was one of a party observing the Transit of Venus from an island in the Caspian Sea. Later he was attached to the Pulkova Observatory until 1876, when he was appointed to the post which he held until his death.

*An Explanation.*—The remark on p. 295 of our last number, that the chief part of Prof. Adams' work was published in the 'Nautical Almanac' of 1880, is open to misconception. It was for the Almanac of 1880 that the phenomena of Jupiter's satellites were first computed by help of Adams' Tables, but the formulæ themselves were given as an Appendix to the 'Nautical Almanac' for 1881.

ERRATUM.—Page 304, line 34, *for* "variability" *read* "invariability."

---

## FROM AN OXFORD NOTE-BOOK.

THE old adage that "there is nothing new under the Sun" would seem applicable to the cœlostat. Perhaps there is a special fitness in its application to an instrument placed so directly "under the Sun" as a heliostat or cœlostat. Professor Stokes wrote to me the other day that "the principle of Lippmann's cœlostat is identical with that of August's heliostat. When I was intending to get a heliostat 40 or 50 years ago, I consulted Professor Miller, who suggested to me August's heliostat. I found it would not be convenient for my purpose on account of the orientation of the room I wanted chiefly to work in, and I got a Silbermann's." In a later letter Professor Stokes adds: "I confess I never looked for August's paper. The thing was mentioned to me in conversation, and when once suggested it is so simple that it lies in a nutshell."

Such rediscoveries are already familiar to us, and will doubtless recur often in the future. There seems no reason to doubt that M. Lippmann made a genuine and independent rediscovery. The marvel is that an instrument of so simple and efficient a character should not have come into general use at the time of its first discovery.

---

BEING away for a holiday I could not satisfactorily look up the previous history of heliostatic arrangements, and must leave this till next month. I referred to the *Encyclopædia Britannica*, but only to meet with disappointment. In the general index, under the word "Heliostat," are the following references:—"signalling instrument, x. 165; xi. 633; improved by Drummond, vii. 480." The articles at these places are on Geodesy, Heliography, and Drummond respectively, and no reference is made to the astronomical use of the instrument. The word siderostat does not occur in the index, though under "siderostatic telescope" reference is made to the article Telescope, where there is a brief note on the form suggested by Grubb (Proc. R. Dubl. Soc. ii. p. 362), which is essentially a polar heliostat. I suppose one cannot expect even the *Encyclopædia Britannica* to be complete, but it is not the first time that it has failed to respond to a query which I thought might reasonably be put to it.

---

THE reference to the siderostatic telescope reminds me that a large instrument of this kind is being made by Sir Howard Grubb for the Cambridge Observatory. The form is not exactly that suggested by him, in which the mirror is outside the telescope and liable to a fall of dew. Dr. Common suggested a modification wherein the telescope should have an arm and the mirror be placed at the junction, thus inside the tube and protected from dew; and this form has been adopted by the Cambridge University Syndicate, and Sir H. Grubb is proceeding with the plans. We shall doubtless hear more of it when the instrument approaches completion.

---

LATER.—Having an hour to spare the other day in the R. A. S. Library, I set to work to turn up the early history of the heliostat. The R. S. Catalogue of Scientific Papers gave no indication about August's work, and for some time my search was unproductive; but at last a reference to the comprehensive 'Handbuch der Astronomie' of Professor R. Wolf (Zürich) gave me a further reference to an article by R. Radau in the 'Bulletin Astronomique' for 1884 (tome i. p. 153), and in this excellent article I found all I wanted. The Cœlostat of M. Lippmann is there described as "l'heliostat d'August (1839) perfectionné par Gruel (1847), réinventé par O. de Littrow (1863) et par M. Prazmowski (1877)." To this long list M. Lippmann's name (1895) must now be added. Not much is said about the instrument in M. Radau's article, and the fact that the image does not rotate is not emphasized. Two disadvantages are mentioned: "le plan d'incidence fait un angle variable avec l'axe de rotation du miroir, et l'angle d'incidence change rapidement, de sorte que le volume du faisceau réfléchi varie beaucoup." Neither of these disadvantages is sensible in eclipse work; but this has not saved the instrument from comparative, if not absolute, neglect. A copious bibliography is given at the end of the article. References to August are apparently to be found in FISCHER, Mechan. Naturlehre, éd. August, t. ii. Berlin, 1840;

ADICKE, Optik, 1839; — GRUEL, Annales de Poggend. t. lx[illegible]ii. 47; but these works not being in the Library I could not carry e investigation further.

---

IN the desultory reading of all sorts of papers and magazines in which one is apt to indulge on a holiday, I came across two paragraphs connected with the heliostat in some form—possibly in both cases the cœlostat. The *Pall Mall Gazette* for August 3, quoting from the *Daily Telegraph*, says that a project for a big refracting telescope of 51 inches aperture and 200 feet focal length, placed horizontally, with heliostatic arrangement, is under serious contemplation by M. Mantois, for the Paris Exhibition of 1900. The second paragraph, in *The People* for August 4, says:—"Astronomical observations on Mont Blanc will shortly commence. The Polar siderostat, superseding the ordinary telescope, has reached Chamounix, and been divided into sections not exceeding 50 lb. in weight so as to be carried on men's shoulders to the observatory."

---

EITHER the holiday season brings with it more than the usual number of paragraphs and references to astronomical matters, or, being on a holiday, one has more leisure to notice them. I have cut out nearly a score of odds and ends during the last three weeks. There is an article on the "Moon" from *The Echo* which winds up as follows:—"A faint conception of the horrors of a lunar day may be formed from an illustration representing a landscape in the Moon in the centre of the mountainous regions of Aristarchus. There is no colour—nothing but dead white and black. The rocks reflect passively the light of the Sun, the craters and abysses remain wrapped in shade, fantastic peaks rise like phantoms in their glacial cemetery, the stars appear like spots in the blackness of space. The Moon is a dead world. She has no atmosphere."

---

ANOTHER paragraph, wherein some astronomical terms caught my eye, turned out to be a "chirological" account of Mr. Gladstone's hands. It appears that his Jupiter finger is short but immensely heavy, and when its owner was in animated conversation "the wonderful gestures and the immense power and individuality of the Jupiter finger" became conspicuous. Mr. Gladstone has also a very long Apollo finger. Unfortunately, the chirologist "could not see the Lines or Mounts, excepting Luna, which was very large from the percussion." Another short note in one of the comic papers gives a list of mistranslations in the illustrated catalogues of the Salons, such as *Le sentier des douaniers*, the coast-waiter's sent; *Le saut du barrage*, the leap of the dam-water; winding up with *La voie lactée* (a representation of the Milky Way)—Milk Street!

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 232. OCTOBER. 1895.

## *Formulæ for Converting Measures on a Photographic Plate into R.A. and Decl.*

In the last number of this magazine Mr. F. W. Dyson gave some convenient formulæ for converting rectangular coordinates on a photographic plate (corrected for refraction, aberration, scale, and orientation) into R.A. and Decl. The subject is more technical perhaps than is usually treated in these pages, but its interest to the average reader is, I venture to think, rapidly growing. Whatever may be the final form of the Astrographic Chart—whether it be a series of prints, easily accessible or purchasable, or a series of numerical measures, or *both* (perhaps most probably both)—the formulæ for converting linear measures into R.A. and Decl., or *vice versâ*, will be constantly required. I have elsewhere expressed the opinion, my steadfastness in which grows with experience, that for many purposes the linear measures on the plates will be much more useful than R.A. and Decl., and that the conversion of such measures wholesale into R.A. and Decl. would be a great waste of time. But this in no way obviates the necessity of the conversion in particular cases; and especially in the case where we wish to compare meridian observations, or existing Catalogues, with the measures on the plates. Even in this case, however, I would suggest the subordination of R.A. and Decl. to the rectangular coordinates—the conversion of the comparatively few coordinates expressed in the former notation into rectangular coordinates, rather than the numerous photographic measures into R.A. and Decl.

But there is a second reason why the formulæ for conversion should be growing in importance generally, independent of the great work of the Astrographic Chart. Up to the present the interest of *taking* the photographs has been paramount; it has been sufficient satisfaction to obtain a plate, and perhaps print and distribute it, merely for general inspection. The result has been much the same as though a large telescope had been put within asy reach of everybody: portions of the heavens have been made visible to those who had no optical means of seeing them. H[illegible] the use of a large telescope for gazing simply is limited; [illegible] possessor of such an instrument soon begins either to desire a micrometer or other apparatus to attach to it for doing some definite work, or to neglect his telescope entirely. Moreover we must not push the analogy of the publication of photographs with accessibility to a large telescope too far; for one of the most interesting features of the latter is wanting, viz., the better opportunity of scrutinizing the planets. Here photography has as yet failed; and a large telescope, with no micrometer, which would not give a satisfactory view of a planet would probably fall into disuse and neglect very quickly. I think, therefore, the time will soon come, if it has not come already, when interest will be shown generally not only in taking photographs, but in measuring and reducing them in some way; and this time will come all the quicker if such measurement and reduction are simplified as much as possible to those who are shy of complicated formulæ or long calculations. For this reason it seems to me that the points noticed by Mr. Dyson are worth dwelling upon, and the formulæ quoted worth simplifying to the utmost extent.

Taking up the formulæ as he left them, viz.

$$\tan(\alpha-\mathrm{A}) = \frac{\xi}{\sin \mathrm{P}-\eta\cos \mathrm{P}},$$

$$\mathrm{P}-p = \eta-\tfrac{1}{2}\xi^2\cot \mathrm{P}-\tfrac{1}{3}\eta^3-\tfrac{1}{2}\xi^2\eta\,\mathrm{cosec}^2\,\mathrm{P},$$

where $\alpha$ and $p$ are the R.A. and N.P.D. of any star,
A and P „ „ of the centre of the plate,
$\xi$ and $\eta$ are the rectangular "standard" coordinates on the plate,
and all these angles are expressed in circular measure.

Let us rewrite the first equation thus:

$$[(\alpha-\mathrm{A})+\tfrac{1}{3}(\alpha-\mathrm{A})^3]\sin \mathrm{P} = \xi(1+\eta\cot \mathrm{P}+\eta^2\cot^2 \mathrm{P}),$$

neglecting powers of $\xi$, $\eta$, and $(\alpha-\mathrm{A})$ beyond the third.

Now let

$$(\alpha-\mathrm{A})\sin \mathrm{P}=\beta,\quad \mathrm{P}-p=\gamma.$$

Then

$$\beta = \xi+\xi\eta\cot \mathrm{P}+\xi\eta^2\cot^2 \mathrm{P}-\tfrac{1}{3}\xi^3\,\mathrm{cosec}^2\,\mathrm{P},$$

$$\gamma = \eta-\tfrac{1}{2}\xi^2\cot \mathrm{P}-\tfrac{1}{3}\eta^3-\tfrac{1}{2}\xi\eta^2\,\mathrm{cosec}^2\,\mathrm{P}.$$

If $\mu$ denote the circular measure of one réseau interval ($=\cdot 00145$), and the quantities are now expressed *in réseau intervals*, we shall have

$$\beta = \xi+\xi\eta(\mu\cot \mathrm{P})+\xi\eta^2(\mu^2\cot^2 \mathrm{P}-\xi^3(\tfrac{1}{3}\mu^2\,\mathrm{cosec}^2\,\mathrm{P}),$$

$$\gamma = \eta-\xi^2(\tfrac{1}{2}\mu\cot \mathrm{P})-\eta^3(\tfrac{1}{3}\mu^2)-\xi^2\eta(\tfrac{1}{2}\mu^2\,\mathrm{cosec}^2\,\mathrm{P}).$$

[*Digression.*—I hope this introduction of a réseau interval, [illegible] 5 minutes of arc, as a unit will not appear too great an innovation and make it seem that the formulæ are applicable to the work o[illegible] art only, and not to other photographs. If this unit is 1 to, the quantities can easily be converted into minutes of multiplying by 5, or into seconds of arc by multiplying by th of which operations are very simple. But it seems to t the unit 5′, with a decimal subdivision, is a very useful practice. The thousandth part of this unit, 0″·3, is not far e quantity to which a *single measure* can be made correctly Chart plates; and the ten-thousandth part, or 0″·03, is a nvenient *minimum divisibile* for making tables and ex- g results. Our ordinary unit of 1″·00 is either too small big. Results expressed to 0″·1 have an appearance of acy, while those expressed to 0″·01 almost certainly profess racy which is not attainable. The unit of one réseau , allowing of a limit 0″·3, thus hits a happy mean, and nade to 0·0001 of a réseau interval, even if the last place sionally one or even two units wrong, are sufficiently e for all practical purposes.]

rning to our formulæ, since $\mu^2 = \cdot 000002$, the quantities ied by $\mu^2$ are very small, unless P is also very small, *i. e.* ar the Pole.

suppose we tabulate values of $\beta$ and $\gamma$ for all integral of $\xi$ and $\eta$ from $-13$ to $+12$, *i. e.* for all the points of tion of the réseau lines. There is not much work in doing d for many purposes we can take $\beta$ and $\gamma$ from such tables , with a very little trouble in interpolating. It will be seen that there is not much work involved in making the Take for instance the term $\xi\eta(\mu \cot P)$. The factor is a constant, and giving $\eta$ the value 1, we put $\xi$ suc- y equal to 1, 2, 3, &c., and quickly perform the multi- ns. The term $\xi^2(\frac{1}{2}\mu \cot P)$ is practically formed at the same ut $2\eta = \xi$ in the table $\xi\eta(\mu \cot P)$. The terms involving $\mu^2$ ll. An hour or two for each zone is amply sufficient to ese tables.

gards the interpolation, not always an easy matter from f double entry, we can make this very simple by means of ry tables. The problem is, having given $\beta$ and $\gamma$ accurately 10·0000, $\eta = 5\cdot 0000$, say to find $\beta$ and $\gamma$ for $\xi = 10\cdot 3486$, 13, or generally having given $\beta_0$ and $\gamma_0$ for $\xi_0$ and $\eta_0$ rs) to find $\beta$ and $\gamma$ for $\xi_0 + x$, $\eta_0 + y$, where $x$ and $y$ are less nity. If we substitute $(\xi_0 + x)$, $\eta_0 + y$ in the formulæ we t

$$
\begin{aligned}
\beta = {} & \xi_0 + \xi_0\eta_0(\mu \cot P) + \xi_0\eta_0^2(\mu^2 \cot^2 P) - \xi^3(\tfrac{1}{3}\mu^2 \operatorname{cosec}^2 P) \\
& + x \\
& + (x\eta_0 + y\xi_0)\mu \cot P \\
& + (x\eta_0^2 + 2y\xi_0\eta_0)(\mu^2 \cot^2 P) - x\xi_0^2(\mu^2 \operatorname{cosec}^2 P) \\
& + xy(\mu \cot P) \\
& + \xi_0 y^2(\mu^2 \cot^2 P) - x^2\xi_0(\mu^2 \operatorname{cosec}^2 P) \\
& + xy^2(\mu^2 \cot^2 P) - x^3(\tfrac{1}{3}\mu^2 \operatorname{cosec}^2 P).
\end{aligned}
$$

Now the first line is $B_0$, given in the tables.

The second line is the simple increment of $\xi_0$.

For the two terms of the third line, $\mu x\eta_0 \cot P$ and $\mu y\xi_0 \cot P$, which are of similar form, we want a table of double entry with 13 columns ($\eta_0 = 1, 2, 3$ &c. to 13); and suitable values of $x$. This will not be a difficult table either to make or use.

The greatest value of any term on the third line is obtained by putting $x$ or $y = 1$ and $\xi_0$ or $\eta_0 = 13$. Thus the greatest value of $2y\xi_0\eta_0\mu^2 \cot^2 P$ is $338\mu^2 \cot^2 P$ or ·0007 $\cot^2 P$, and hence a miniature table of a few terms only is required.

The greatest value of $xy\,(\mu \cot P)$ is ·0014 $\cot P$, and another very small table is required.

The terms in the sixth and seventh lines may be neglected unless P is very small.

Similarly for $\gamma$ we have

$$\begin{aligned}\gamma = {} & \eta_0 + y \\ & -\xi_0 x(\mu \cot P) \\ & -y\eta_0^2\mu^2 - (y\xi_0^2 + 2x\xi_0\eta_0)(\tfrac{1}{2}\mu^2 \operatorname{cosec}^2 P) \\ & -x^2(\tfrac{1}{2}\mu \cot P).\end{aligned}$$

The first line requires no further explanation.

For the second line the table already constructed for the similar terms in $\beta$ is again available; and for the third and fourth lines very small tables of a few terms only are required when $\xi_0$ and $\eta_0$ or $x$ and $y$ are large.

*Summary.*—Thus we require, for the ready conversion of $\beta$ and $\gamma$ into $\xi$ and $\eta$:

(1) A table of double entry giving $\beta$ and $\gamma$ for every intersection of the réseau lines.

(2) A table giving $x\xi(\mu \cot P)$ [also available for $x\eta\,(\mu \cot P)$ or $y\xi(\mu \cot P)$] for integral values of $\xi$ and $\eta$.

(3) Four very small tables giving terms which rarely amount to ·001, and may often be neglected.

It seems to me that tables of this kind will be of great practical use.

Two other points remain to be noticed. The first is the inversion of these formulæ to get $\xi$ and $\eta$ in terms of $\beta$ and $\gamma$. The inversions are readily written down as follows:—

$$\begin{aligned}\xi &= \beta - \beta\gamma\mu \cot P + \tfrac{1}{6}\beta^3\mu^2[2 - \cot^2 P] \\ \eta &= \gamma + \tfrac{1}{2}\beta^2\mu \cot P + \mu^2[\gamma_3^3\mu^2 + \tfrac{1}{2}\beta^2\gamma(1 - \cot^2 P)].\end{aligned}$$

These formulæ are very similar to those already discussed, and a slight modification of the same tables will enable $\xi$ and $\eta$ to be found in terms of $\beta$ and $\gamma$.

The second point is the deduction of $\beta$ from $(\alpha - A)$. When $\beta$ is expressed in réseau intervals and $\alpha - A$ in seconds of time, we have

$$\beta = \frac{1}{20}(\alpha - A)\sin P.$$

will perhaps be advisable to tabulate this quantity for values of —A) from (say) 1 to 400. Then if $(\alpha-A)=237^{s}\cdot56$, we get e value of $\beta$ by adding together the values for 235 and 2·56; 237 and ·56, &c.

I am proceeding with the formation of these tables for the xford Zones (+25° to +31°); but as we may not be able to :tend the tables to other zones, at least for some time, this brief count of the method may be of use to others working at a fferent part of the sky. If the tables prove a success, it will be sirable that a complete series of them should ultimately be iblished. H. H. Turner.

## *Some Astronomical Records in ancient Chinese Books.*

[Continued from p. 325.]

On the first day of the last month of Autumn, the Sun and oon did not meet harmoniously in Fang." This passage occurs the ancient classic, the 'Shu Ching,' in the 'Yin Cheng,' one of e books of the Hsia dynasty; according to Chinese commen- ors this passage refers to an eclipse of the Sun in Fang, the urth of the Chinese 28 constellations. The last month of tumn, according to the Hsia calendar, is the ninth month, the onth after that which contains the autumnal equinox. At this uinox, as we have seen, the culminating star was Hsü, $\beta$ Aquarius, d the Chinese astronomers could easily infer that the Sun was en constellations farther back, or in Fang. Fang extends from out $\pi$ to $\sigma$ Scorpii, a distance measured along the ecliptic almost ıal to 5°. Approximately, the limits of Fang in longitude were follows:—

2250 B.C. between 184° 12′ and 189° 12′,
2150 B.C. „ 185 34 „ 190 34,
2050 B.C. „ 186 56 „ 191 56.

An eclipse, however, very near the constellation Fang, will isfy the conditions of the text, as at that early period, and for a eat many centuries after, the Chinese astronomers were unable *urately* to determine the position of the Sun among the stars.

The date of the accession of the emperor Chung K'ang is known. Indeed, all dates in Chinese history before the Chou nasty are not only unknown, but those given in the current onology are, as we shall presently see, erroneous. The great portance therefore of settling the date of this eclipse is apparent. In all probability, Chung K'ang reigned sometime between the ırs 2050 B.C. and 2158 B.C. I have therefore examined all ırs between these two dates on which an eclipse of the Sun in constellation Fang, and on the first day of the ninth moon, ght be looked for. A short sketch of the manner of research d the results arrived at may not prove very uninteresting.

Prof. Newcomb has published tables for the calculation o[illegible] eclipses between the limiting dates 700 B.C. and 2200 A.D. Thes[illegible] tables I have extended, so as to embrace all eclipses of the Su[illegible] between the dates 2200 B.C. and 2200 A.D. These tables, th[illegible] extended, I have used in the examination of this eclipse. No[illegible] an eclipse of the Sun in Fang can only occur when the Moon[illegible] node is in or near Fang. We easily calculate that on the yea[illegible]rs 2154 B.C., 2135 B.C., 2117 B.C., 2098 B.C., 2079 B.C., 2061 B.[illegible]C., 2042 B.C., the Moon's ascending node was in Fang, and on t[illegible]he years 2164 B.C., 2145 B.C., 2126 B.C., 2108 B.C., 2089 B.C., 2071 B.[illegible]C., 2052 B.C., the Moon's descending node was in or near Fa[illegible]ng. Accordingly, I have examined all the above dates, whether or [illegible]ot such an eclipse was visible in China, and find that, on nearly all the above years, no such an eclipse was visible in the north of China.

The situation of the capital of Chung K'ang is a disputed po[illegible]nt. Some hold it was at An Yi Hsien, in Shan Hsi, latitude 35° 8' N. and longitude about 111° 30' E. of Greenwich. Others say[illegible] it was at T'ai K'ang Hsien, in Honan, latitude 34° 7' W. and l[illegible]ongitude about 115° E. of Greenwich.

Some Chinese astronomers, as well as the Jesuits, have cal[illegible]culated that the eclipse of the year 2154 B.C. is the one in quest[illegible]ion. This, however, cannot be the case, as during the eclipse it [illegible] was night in China.

This, however, is no reflection on the accuracy of the ca[illegible]culations of those learned men, as since their time the tables of the Sun and Moon have been made much more accurate.

On October 22, 2136 B.C., on the ninth of the cycle of d[illegible]ays, the day yen$^2$ shen$^1$, there was an eclipse of the Sun visibl[illegible] in N. China.

At An Yi Hsien, it commenced about 10 A.M. and was [illegible]over about half an hour after noon. The magnitude was about [illegible] 0·5. The longitude of the Sun at the moment of true conjunction [illegible] was 191° 38', so that the eclipse took place very near Fang. The [illegible] day was the first of the ninth moon.

In the following year, 2135 B.C., on Oct. 11, the third of [illegible] the cycle of days, the day ping$^3$ yin$^2$, there was an eclipse of the [illegible] Sun also visible in the northern hemisphere. At An Yi Hsien[illegible] the eclipse began about 4$^h$ 30$^m$ in the afternoon, and lasted ti[illegible]ll 7. The magnitude was about 0·58. At the time of conjunction [illegible] the longitude of the Sun was 180°·28, so that the eclipse occu[illegible]rred very near Fang.

On Oct. 12, 2108 B.C., an eclipse of the Sun took place in F[illegible]ang, visible at An Yi Hsien. It began about 6.48 P.M., ended 8.27 [illegible]P.M., and so was partly visible. The magnitude was small, only 0·3[illegible] 6.

In the following year, 2109 B.C., Oct. 24, another eclips[illegible] of the Sun occurred in Fang and was visible at An Yi Hsien. It began at 4.54 P.M. and ended at 7 P.M. The magnitude was 0·[illegible]5.

We meet with no other eclipse visible in the north of Ch[illegible]ina ıg the required conditions till the year 2071 B.C. On that year, the 51st of the cycle of days, the day chia' was an eclipse of the Sun. At T'ai K'ang Hsien, it minutes after 7 in the morning and lasted till 9.30 A.M. tude was 0·34. At conjunction, the longitude of the )3°·2.

pse therefore satisfies the required conditions, the Sun being very near Fang and the day being the first day h moon.

)se of the year 2127 B.C. deserves special consideration, erally considered to have been the one in question. mers, in an introduction to Legge's 'Shu Ching,' says: )wever, who like the year 2127 B.C. as the date of the y adopt it now without fear of its being hereafter isible." I find, however, that this eclipse was not .er in An Yi Hsien or T'ai K'ang Hsien. The line of )ntact ran considerably north of either of these two n Oct. 13 of this year, the 47th of the cycle of days, ng hsü, there was an eclipse of the Sun. At con- ıe longitude of the Sun was 181°·92, so that, so far, satisfies the required conditions.

:, that this eclipse was not visible at all in China proper by the following calculation of the southern line of tact :—

| ich Time. | Lat. | Long. |
|---|---|---|
| : 11·705 | 66° 14′ N. | 96° 10′ 30″ E. |
| 12 | 58 44 | 145 15 E. |
| 12·2 | 55 33 | 152 28 E. |
| 12·4 | 52 7 | 158 35 E. |
| 13 | 41 33 | 171 18 E. |
| 14 | 23 33 | 172 53 W. |

ıbove table we see that the most southern line, at all vhich the Moon will be seen just to graze the Sun's ssed north of China proper; so that the eclipse of the B.C. cannot be the one mentioned in the 'Shu Ching.'

e above investigation we see that the eclipse referred to u Ching' must be that of one of the years 2136, 2135, 8, or 2071 B.C.; which of these dates is to be taken etermined by other considerations.

pse of the year 2136 B.C. is most probably the one in ıs it occurred in the middle, the busiest part of the day. likely to me that the astronomers Hsi and Ho were ath, not because they did not predict the eclipse, but hen it did occur, they were drunk and unable to perform er duties. The account in the 'Shu Ching' does not otal or even an eclipse of large magnitude. The con- bustle that is mentioned was not owing to fear, but to their being totally unprepared, owing to the incapable condition of the two astronomers.

It will be interesting here to note that, even at present by Imperial command, special rites are performed during solar and lunar eclipses. A president from each of the six boards, with two inferior officials, dressed in their official clothes, proceed to the T'ai[3] Ch'ang[2] Ssu. When the eclipse begins, they change their robes for common garments made of plain black material, and, kneeling down, burn incense. The president then beats one stroke on a gong, and the ceremony is taken up by all the attendant officials.

Some admirers of the Chinese cite this eclipse as a proof of the early proficiency attained by the Chinese in astronomical calculations. I find no ground for that belief in the text. Indeed, for many centuries later, the Chinese were unable to predict the position of the Sun accurately among the stars. They relied wholly on observation to settle their calendar year by year, and seem to have drawn no conclusions or deductions from their observations. Their calendar was continually falling into confusion. Even at the beginning of this dynasty, when the Jesuits came to China, the Chinese astronomers were unable to calculate accurately the length of the shadow of the Sun at the equinoxes and solstices. It seems to me therefore very improbable that they could have been able to calculate and predict eclipses.

The common chronology gives the year 2158 B.C. as the date of the accession of Chung K'ang and the year 2148 B.C. as that of his death. Between these two dates, as we have seen, no eclipse of the Sun, as recorded in the 'Shu Ching,' took place. We must therefore alter the current chronology. It is not stated in the 'Shu Ching' on what year of the reign of Chong K'ang this eclipse took place. If we suppose it happened during the first year of his reign, we must fix on the year 2136 B.C. as the date of the accession of Chung K'ang and 2124 B.C. as that of his death.

S. M. RUSSELL.

[To be continued.]

---

## *British Association: Extract from the President's Address.*

In the earlier part of this century, whilst the sidereal universe was accessible to investigators, many problems outside the Solar System seemed to be unapproachable. At the third meeting of the Association, at Cambridge, in 1833, Dr. Whewell said that astronomy is not only the queen of science, but the only perfect science, which was "in so elevated a state of flourishing maturity that all that remained was to determine with the extreme of accuracy the consequences of its rules by the profoundest combinations of mathematics, the magnitude of its data by the minutest scrupulousness of observation." But in the previous year—viz., 1832—Airy, in his report to the Association on the progress of astronomy, had pointed out that the observations of the planet Uranus could not be united in one elliptic orbit—a remark which turned the attention of Adams to the discovery of Neptune. In his report on the position of optical science in 1832, Brewster suggested that with the assistance of adequate instruments "it would be possible to study the action of the elements of material bodies upon rays of artificial light, and thereby to discover the analogies between their affinities and those which produce the fixed lines in the spectra of the stars; and thus to study the effects of the combustions which light up the suns of other systems." This idea has now been realised. All the stars which shine brightly enough to impress an image of the spectrum upon a photographic plate have been classified on a chemical basis. The close connection between stars and nebulæ has been demonstrated; and while on the one hand the modern science of thermodynamics has shown that the hypothesis of Kant and Laplace on stellar formation is no longer tenable, inquiry has indicated that the true explanation of stellar evolution is to be found in the gradual condensation of meteoric particles, thus justifying the suggestions put forward long ago by Lord Kelvin and Prof. Tait. We now know that the spectra of many of the terrestrial elements in the chromosphere of the sun differ from those familiar to us in our laboratories. We begin to glean the fact that the chromospheric spectra are similar to those indicated by the absorption going on in the hottest stars, and Lockyer has not hesitated to affirm that these facts would indicate that in those localities we are in the presence of the actions of temperatures sufficiently high to break up our chemical elements into finer forms. Other students of these phenomena may not agree in this view, and possibly the discrepancies may be due to default in our terrestrial chemistry. Still, I would recall to you that Dr. Carpenter, in his Presidential Address at Brighton, in 1872, almost censured the speculations of Frankland and Lockyer in 1868 for attributing a certain bright line in the spectrum of solar prominences (which was not identifiable with that of any known terrestrial source of light) to a hypothetical new substance which they proposed to call "helium," because "it had not received that verification which, in the case of Crooke's search for thallium, was afforded by the actual discovery of the new metal." Ramsay has now shown that this gas is present in dense minerals on earth; but we have now also learned from Lockyer that it and other associated gases are not only found with hydrogen in the solar chromosphere, but that these gases, with hydrogen, form a large percentage of the atmospheric constituents of some of the hottest stars in the heavens*. The spectroscope has also made us acquainted with the motions and even the velocities of those distant orbs which make up the sidereal universe. It has enabled us to determine that many stars, single to the eye, are really double, and many of the conditions of these strange systems have been revealed. The rate at which matter is moving in solar cyclones and winds is now familiar to us. And I may also add that quite recently this wonderful instrument has enabled Prof. Keeler to verify Clerk-Maxwell's theory that the rings o Saturn consist of a marvellous company of separate moons—as i were, a cohort of courtiers revolving round their queen—with velocities proportioned to their distances from the planet.

---

* Joannes Marcus Marci, of Kronland, in Bohemia, was the only predecessor of Newton who had any knowledge of the formation of a spectrum by a prism. He not only observed that the coloured rays diverged as they left the prism,

At their third meeting the Association urged the Governmen to establish magnetic and meteorological observatories in Grea Britain and her colonies and dependencies in different parts of the earth, furnished with proper instruments, constructed on uniform principles, and with provisions for continued observations at those places. In 1839 the British Association had a large share in inducing the Government to initiate the valuable series of experiments for determining the intensity, the declination, the dip, and the periodic variations of the magnetic needle, which were carried on for several years at numerous selected stations over the surface of the globe, under the directions of Sabine and Lefroy. In England systematic and regular observations are still made a Greenwich, Kew, and Stonyhurst. For some years past similar observations by both absolute and self-recording instruments have also been made at Falmouth, close to the home of Robert Were Fox, whose name is inseparably connected with the early history of terrestrial magnetism in this country—but under such grea financial difficulties that the continuance of the work is seriously jeopardised. It is to be hoped that means may be forthcoming to carry it on. Cornishmen, indeed, could found no more fitting memorial of their distinguished countryman, John Couch Adams than by suitably endowing the magnetic observatory in which he took so lively an interest. Far more extended observation will be needed before we can hope to have an established theory as to the magnetism of the earth. We are without magnetic observation over a large part of the Southern Hemisphere. And Prof Rücker's recent investigations tell us that the earth seems, as i were, alive with magnetic forces, be they due to electric current or to variations in the state of magnetised matter; that the disturbances affect not only the diurnal movement of the magnet but that even the small part of the secular change which has been observed, and which has taken centuries to accomplish, is interfered with by some slower agency. And, what is more important

---

but that a coloured ray did not change in colour after transmission through prism. His book, 'Thaumantias, liber de arcu cœlesti deque colorum apparentium natura,' Prag, 1648, was, however, not known to Newton, and had n influence upon future discoveries.

he tells us that none of these observations stand as yet upon a firm basis, because standard instruments have not been in accord; and much labour, beyond the power of individual effort, has hitherto been required to ascertain whether the relations between them are constant or variable.

## *Selenographical Notes.*

SCHRÖTER'S NEWTON.—This large, partially enclosed area, closely associated with the southern flank of Plato and with the magnificent ridge running northwards from the bright little ring-plain Piazzi Smyth to the east side of this formation, presents, under many phases of illumination, all the appearance of a degraded walled-plain, which was possibly at one time of a more imposing type than Plato itself. One is especially impressed with this idea, if it be observed from about the time when the brilliant Pico is on the morning terminator till Plato is well in sunlight. Under these conditions, the former and two or three less conspicuous isolated mountains east of it are seen to follow the line of a rampart of which they are the only prominent relics. West of Pico, this border forms a regular curve, bending gradually round to the south-western side of Plato, and becoming wider and loftier as it approaches the limits of this formation. During the greater part of its course it is very clearly double, the inner portion probably representing the remains of a lower terrace of the original border. This duplication is not shown either by Mädler or Neison, and only partially in Schmidt's chart, though it is obvious enough under a low morning sun. East of Pico the remains of the wall are less easily traceable, being lower, more irregular, and detached, and ultimately becoming more or less confounded with outlying heights pertaining to the western termination of the Teneriffe Mountains. Still, in spite of this, under favourable conditions, the formation may be easily traced and its distinctive character made unmistakably apparent. The curious association of the curved west border of Schröter's Newton with one of the most prominent and remarkable ridges on the visible surface (that which runs north from Piazzi Smyth) will repay careful observation.

The interior of this great enclosure, which represents an area more than three times as great as that of Plato, and is almost as beautiful an object, is by no means devoid of detail. Mädler shows a crater on the western side of the interior, which, 1870, May 8, $9^h\ 30^m$, I saw with a 4-in. achromatic, as a crater-cone casting a very prominent shadow, and on many subsequent occasions, under a high light, as an ill-defined white spot, similar in character, but more easily glimpsed, to those within the neighbouring Plato. In addition to this, I have detected four additional craters of a smaller type on the southern side of the interior, north of Pico, two of which are shown by Schmidt. The most westerly of these objects is also represented under a high sun by a faint white spot nearly as obvious as that which occupies the site of the crater-cone. In addition to these features there are many ridges on the floor, the most conspicuous lying on the north-west side of it.

The north-west limits of this curious formation are defined, from the bright mountain *k* (on the south-west of Plato) for nearly 30 miles, by a precipitous cliff, descending from the plateau, traversed by the well-known valley which cuts through the south-west wall of Plato, and terminating suddenly at a bright mountain on the rampart, at the foot of which the 'fault' that crosses the floor ends.

T. Gwyn Elger.

Beaumont House, Shakespeare Road,
Bedford, 1895, Sept. 19.

## CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

### *The Visibility of the Dark Side of Venus.*

Gentlemen,—

The passage in Derham's 'Astro-Theology' which my friend Mr. Prince seems to have overlooked is in the fifth chapter of the first book, at pp. 106, 107 of the first edition, which was published in 1715. It runs thus:—

"And although *Venus*, *Mercury*, and our *Moon* have *Phases*, and appear sometimes Falcated, sometimes Gibbous, and sometimes more or less round; and even *Mars* too, in its Quadratures, become Gibbose; yet at such times as these Planets shew their full Phases, they are found to be sphærical, and only lose this figure by vertue of their position to the Sun, to whom they owe their Light. And this sphæricity or rotundity is manifest in our *Moon*, yea and in *Venus* too; in whose greatest Falcations the dark part of their Globes may be perceived, exhibiting themselves under the appearance of a dull and rusty colour."

It will be noticed that in the English edition of Arago's 'Popular Astronomy' by Smyth and Grant, the word "rusty" appears as "ruddy," presumably by a translation into French and re-translation into English. (The French is "rougeâtre.")

Miss Clerke points out ('History of Astronomy,' p. 315) that this secondary light of Venus was noticed by Riccioli, whose perception of it is the oldest with which we are acquainted, and appears to have been overlooked by Prof. Schafarik in the paper referred to by Mr. Prince. It seems to me, however, that Riccioli was uncertain how far the appearance noticed by him was due to the colour of the glass of his telescope; and indeed before achromatic lenses were invented there must always have been a difficulty.

kind. His remarks are given in Book vii. § 1, ch. 2, of the
gestum Novum,' where, after stating that he had frequently
ed Venus when horned as well as gibbous, he refers
ilarly to an observation made by him on January 9, 1643;
es a drawing of the shape of the planet (which is similar to
the Moon when about six days old), and says "Erat vero
versus rubicunda, in medio flavescens, et in parte a Sole
cæruloviridis; sed illa varietas a vitro tubi probabiliter

phenomenon is of considerable interest, and attention will
ess be paid to it now that Venus is again near inferior
ction with the Sun. Prof. Schafarik in his paper in the
Association Report (year 1873, p. 404) enumerates the
s causes which had been suggested for it, and then brings
d one which certainly had the merit of novelty, that it was
o phosphorescence from immense seas on Venus, which
with an abundance of animal life difficult to be conceived."
ose that most of us will agree with Miss Clerke that this
tion cannot "be seriously entertained," and that that of
that the appearance is produced by a very extensive twilight,
e probable.

Yours faithfully,
W. T. LYNN.

heath, 1895, Sept. 10.

## *The Eclipse of* A.D. 1030.

TLEMEN,—

As Mr. Lynn in your last number has referred to the
r annular eclipse of 1030, it may not be useless to call the
ion of your readers to the fact that this eclipse did *not* take
luring the battle of Stiklastad, but more than a month later.
ronicles can therefore not render any assistance in deter-
g the situation of the line of central eclipse. In his work
Bekehrung des norwegischen Stammes zum Christenthume'
i., Munich, 1856, pp. 533–540), Prof. Konrad Maurer has
e length discussed the question as to the date of the battle,
shows that it cannot have taken place on Aug. 31, the day
eclipse. The Icelandic Annals state that King Olaf died
ednesday, July 29, 1030; the younger Saga, as well as
the historian, give the same day of the week and the same
ut do not mention the year. That the battle took place on
dnesday is also confirmed by the older Olaf's Saga, and
9 was soon after made the feast day of the canonized king.
nonk Theodoric, who wrote his history of the Norwegian
about the end of the 12th century, says that the battle was
on Wednesday, July 29, 1029 (*sic*), so that the week day
te must be considered as firmly established.

vat, the bard, whose description of the darkness during the
is quoted by Snorre, was no doubt a contemporary of King
but he was in Rome at the time of the battle and heard the
outside Norway, as he acknowledges himself. Moreover, he

was a warm friend of the king and a most energetic Christian, so he cannot be considered an unbiassed witness. Evidently the account of the darkness occurring at the death of Christ was imitated by the admirers of the Norwegian martyr; in fact the older Olaf's Saga expressly compares the two events, and points out how God's anger was manifested on both these occasions. But neither the Fagrskinna Saga nor Theodoric mention the darkness during the battle.

If a total eclipse had been seen in Belgium in July or August 1st 1815, does anyone doubt that it would soon in the minds of many people have become an indisputable fact that it took place on June 18, perhaps at the very time when Blücher appeared on the scene?

Yours faithfully,

Armagh Observatory, 1895, Aug. 8. J. L. E. **Dreyer.**

## *A Proof of the Law of Gravitation.*

Gentlemen,—

In No. 230 of the 'Observatory' I find a short article on "A Proof of the Law of Gravitation," which, as you remark, is easily shown to be a fallacy, as $k$ is not an abstract number, but of the dimensions

$$\frac{(\text{Length})^3}{(\text{Time})^2 \times \text{Mass}}:$$

and, further, these dimensions only suit the Newtonian form of gravitation. If the force had been proportionate to $\frac{1}{r^{2+\delta}}$, the constant $k$ ought to have been determined accordingly. It is, however, shown by Laplace, in quite another way, that it is very improbable that any fraction should have to be added to the exponent 2.

If the Newtonian expression is not the final one, but only the first term of a series, the force of gravity can surely only be altered by exceedingly small additional terms. I have myself tried to find a theory for the mechanism of gravitation (see 'Proceedings of the Society of Science of Christiania,' No. 12, 1892), and have been led to the following expression for the attraction of a sphere:

$$\frac{km}{r^2}\left(1 \div \frac{3}{4} hsd + \frac{2}{1+\gamma}\frac{V_1}{U}\left(1 \div \frac{1}{5}\frac{d^2}{r^2} + \ldots\right) + \ldots\ldots\right),$$

where $hsd$ for each mass is a small constant of the order $\frac{1}{10^8}$* for the Earth, $\gamma$ a real fraction, $\frac{V_1}{U}$ of the order $\frac{1}{10^{22}}$, $d$ always small in comparison to $r$. The units are C.G.S.

---

* This constant would chiefly alter the determination of the mass of a heavenly body, as the expression may be written:

$$\frac{km(1+\text{Constant})}{r^2}(1+\text{Constant})\frac{V_1}{U}\left(1+\frac{1}{5}\frac{d^2}{r^2}\right).$$

These alterations from the Newtonian form would only cause a difference too small to be sensible in the motion of the planets and satellites for a very long period.

The gravitational æther, supposed to be the cause of the phenomenon of gravitation, would only cause an exceedingly small resistance in the opposite direction of motion of a heavenly body. For the Earth it would only alter the mean motion $1''$ in 100 years, with acceptance of the above limits for the constants.

Yours faithfully,
Drammen, 1895, Aug. 20. HANS I. KIÆR.

## *Stationary Meteor-radiants.*

GENTLEMEN,—

Mr. Denning's note on the great meteor of July 7, 1895, affords a good illustration of the fact of stationary radiation. Large meteors or fireballs have, he states, been observed from practically the same point on April 21, May 12, and May 29, and he deduced it from 13 meteors brighter than usual observed between April 19 and May 5. "There are in fact," he adds, "showers of Librids interspersed with fireballs during the whole of the first half of the year." In his own Catalogue I find a radiant at 208° −8° on Jan. 19 and 25, at 210° −13° on February 15 and 21, at 210° −10° on April 7 and 16, and at 207° — 7° on April 22. From Italian observations he deduced a radiant at 204° −8° for the period Mar. 31–April 12 and at 209° −8° for the period May 3–15. Tupman obtained 210° −6° for February 5 to 11, and Sawyer 206° −8° for April 12 to 26. Some other examples could be added. Considering that meteors from a point so far south may readily escape observation, and that for the same reason a difficulty exists in fixing the exact radiant, there seems to be little doubt that a shower from about 210° −10° continues without sensible intermission or shifting from the middle of January till July.

Is it possible to suppose that we are here dealing with a succession of totally independent showers, the apparent coincidence of whose radiant-points is merely due to the effect of the Earth's motion in obliterating the distinction between the true radiants? And this radiant is but one of a great number—Mr. Denning enumerates 45 without arriving at completeness—which exhibit the same features, often in a more marked degree. The coincidences are far too numerous to be explained by chance, as I think anyone who will investigate the subject carefully and without prejudice will see. The only alternatives which remain seem to me to be these: first, that the current theory on the subject is radically erroneous, and, secondly, that there is some kind of physical connection among meteor-systems which has the effect of counterbalancing the Earth's motion and making the connected systems appear to be identical. What kind of connection would produce the effect I do not know; but I feel confident that the meteors which apparently come from the same point at different seasons of the year are physically connected.

Truly yours,
Dublin, 1895, Sept. 14. W. H. S. Monck.

---

## PUBLICATIONS.

The Longitude of Batavia*.—Having seen the note in our last number on the Longitude of Madras, Prof. Oudemans has kindly sent us a copy of a section he is adding to the fourth volume of his report on the Triangulation of Java, which relates very closely to our subject, as will be seen from the following extracts from Prof. Oudemans' letter to us. He says :—"I have just finished the fourth volume of my Report on the Triangulation of Java, containing among others the Latitudes and Longitudes of the primary stations. As these are measured from the old time-signal at Batavia (now removed to the new harbour, Tandjong Priok), I considered it desirable to add a paragraph on 'Die Länge von Batavia,' of course measuring from Greenwich. The problem I proposed to myself was to bring this longitude 'up to date,' and for this it was necessary to compare the Russian chain Pulkova—Vladivostok with the British and American chain Aden—Vladivostok and to divide the difference of the two ($0^s.43$) between the different links. Madras and Singapore are in the last-mentioned chain ; I wanted Singapore, but the longitude of Madras came out as a bye-product, $5^h\ 20^m\ 59^s.452$."

Prof. Oudemans begins this section by giving for comparison some details of determinations of the longitude of Batavia made by means of lunar observations previous to the era of telegraphy. These observations, which were made about the year 1850, are separated under the heads which, with the result from each series, are given below :—

| | h | m | s |
|---|---|---|---|
| From Moon-culminations the longitude was found to be | 7 | 7 | 17·5 |
| From observation of the declination of the Moon and comparison stars | 7 | 7 | 16·8 |
| From Occultations of stars | 7 | 7 | 12·3 |

The mean result deduced from these by an ordinary system of weighting was $7^h\ 7^m\ 14^s.4$; but using Prof. Challis' method of discussion given in the 'Nautical Almanac' for 1853, which gives a greater weight to the observations of occultations, the longitude of Batavia appears as $7^h\ 7^m\ 12^s.5$, with a probable error of $0^s.38$. The telegraphic determinations of the longitude of Batavia depend essentially on the value of the longitude of Madras. Prof. Oudemans adopts provisionally for this $5^h\ 20^m\ 59^s.349$, which is the

---

* 'Die Länge von Batavia aus der 4ten Abtheilung des Berichtes über die Triangulation von Java.'

value derived by Sir G. B. Airy from the chain through Mokat-
Suez, Aden, and Bombay, and results from applying two small
:ctions to the value given in our last number. In 1870–71
. Oudemans, with Herr Soeters, measured the arc Batavia—
apore $0^h\ 11^m\ 50^s{\cdot}985$, and in 1871 he, in conjunction with
Pogson, measured the arc Singapore—Madras $1^h\ 34^m\ 23^s{\cdot}365$.
ill be seen by adding these figures that the longitude of Batavia
us found $7^h\ 7^m\ 13^s{\cdot}699$ E. of Greenwich.

ie arcs Batavia—Singapore, Singapore—Madras, giving the
rence of longitude between Batavia and Madras, have also
measured by officers of the American Navy, Commanders
n Davis and Norris, whose determination gives the longitude
Batavia $7^h\ 7^m\ 14^s{\cdot}408$, which is $0^s{\cdot}708$ greater than Prof.
:mans' result. But there is some evidence which may be
to estimate the relative accuracy of these values, for the
measured by the American officers are part of a series of
raphic determinations made by them connecting several
lians in Japan, China, and the East Indies, and the arc
apore—Madras is a link of the chain, through Cape St. James,
g Kong, and Shanghai, which gives the longitude of Vladi-
ok; and as the longitude of this last-named place from Pulkova
also been measured by Russian officers, a comparison of the
results furnishes a check on the determined longitudes of the
mediate stations.

ith the adopted longitude of Madras as given above the
rence of longitude, Vladivostok—Greenwich, determined by
American observers, is $8^h\ 47^m\ 30^s{\cdot}869$, and taking the
rence of longitude Pulkova—Greenwich as $2^h\ 1^m\ 18^s{\cdot}65$, the
tude of Vladivostok determined by the Russian chain is
$^m\ 31^s{\cdot}300$, which is $0^s{\cdot}431$ greater than that by the other
:. It is this difference which Prof. Oudemans refers to, and
h he has reconciled by discussing results and evolving correc-
to the several links which make up each chain. He thus
the longitude of Fort Canning flagstaff at Singapore to be
$5^m\ 23^s{\cdot}545$ East * and adding the value of the arc Batavia—
apore found by himself and Herr Soeters, the resulting longi-
of the old Time-signal station at Batavia appears as
$^m\ 14^s{\cdot}530$. As has been said, the discussion also furnishes
w value of the longitude of the Madras Observatory. By
of Prof. Auwers' discussion of the link Madras—Aden (Ast.
., No. 3180), and by the application of the empirical cor-
ons to make the determinations of the longitude of Vladi-
ok agree, the longitude of Madras becomes $5^h\ 20^m\ 59^s{\cdot}452$.

ie comparison of these two chains is most interesting, and the
arative smallness of the difference of the totals gives assur-
that probably no one of the links is greatly in error. We

---

The determinations of longitude of places in Australia at present depend
e accuracy of the assumed longitude of Singapore. The connecting-link
pore—Port Darwin was made in 1883, when the longitude of the flagstaff
dopted as $6^h\ 55^m\ 23^s{\cdot}50$ E.

have read this addendum to Prof. Oudemans' great work with much interest, supplying as it does so opportunely such valuable information on a subject now much in our minds.

Hongkong.—The annual volume of 'Observations and Researches' for 1894 has just been issued. From Dr. Doberck's report we find that during the greater part of the year the observatory was in charge of Mr. Plummer, the chief assistant (the director being absent from the colony on a well-earned leave), the charge of the weather forecasts and storm-warnings being undertaken by Mr. Figg, the first assistant. A valuable investigation on the Typhoons of the year, by Mr. Figg, is appended to the annual official report. The monthly tables and reductions, extending to 108 pages of letterpress, follow in the complete and elaborate form which has marked the publications of this observatory since its establishment; and we are pleased to note the care with which the observations appear to have been made, and the promptitude with which they have been reduced and published. We are still anxious to see some astronomical work done. W. C. N.

Catalogue of Nebulæ*.—Dr. Dreyer, by the publication of this Index, brings his New General Catalogue of Nebulæ up to the end of 1894. As he remarks, most of the objects are faint and only within reach of the largest telescopes, and for the most part uninteresting, except as forming individuals in the innumerable host of similar objects; still if they are found, it is useful to have them catalogued and arranged according to some definite plan. The plan followed with the present 1529 objects is the same as that of the New General Catalogue. Dr. Dreyer is to be commended for attacking the subject thus early, for if the numbers go on increasing in anything like this proportion, a few years would make the task too gigantic. At the end of the catalogue are notes and corrections to the New General Catalogue.

Stockholm. *Hugo Gyldén.*—We have received four separate pamphlets from Stockholm. The first two contain meridian observations made 1879–80. The third contains "Table des Perturbations du premier ordre des petites planètes par Jupiter," by Dr. H. Masal; and the fourth is a treatise 'Sur la transformation des Agrégats périodiques,' by H. Gyldén.

An Elementary History of Astronomy †.—Another lady has entered the field of writers of astronomical books. Miss Lucy Taylor's book, 'Astronomers and their Observations,' which forms

---

* 'Index Catalogue of Nebulæ found in the years 1888 to 1894, with notes and corrections to the New General Catalogue,' by J. L. E. Dreyer, Ph.D. (Reprint from 'Memoirs' of the R.A.S. vol. li.)

† 'Astronomers and their Observations,' by Lucy Taylor. The World's Wonder Series. (London: Partridge and Co.) Price 1*s*. 6*d*.

ι series of books written for popular or even juvenile
admirably fulfils its purpose. In fact, as a criticism on
k, a short extract from its preface (which is written by
T. Lynn) might very well suffice:—"The book may be
y taken up by those who have no previous acquaintance
subject; and the information conveyed, if not deep, is
nd will incite to further study." The first four chapters
a brightly written and comprehensive sketch of as-
's up to and including Newton. The remaining eight
give a concise account of the facts of modern astronomy,
n a readable, even fascinating, manner. We can recom-
is as a cheap gift-book for a small boy.

:T ON THE TOTAL ECLIPSE OF THE SUN, OBSERVED AT MINA
, CHILE, 1893 April 16. By J. M. SCHAEBERLE,
ner in the Lick Observatory.—We have just received
ial report of the results of the Lick Observatory Expedi-
Chile to view the above eclipse. The expenses of the
)n were defrayed by Mrs. Phebe Hearst, a benefactor of
ervatory.

ost important feature of the expedition was the employ-
the Clark lens of 5 inches aperture and 40 feet focal
It being considered impossible to construct a rigid tube of
th, the objective was mounted on a pier of its own and a
vas tube was constructed, while the slide carrying the plates
ed by clockwork along a rail inside the camera, the proper
)n of the rail and speed of the clock being previously com-
The mounting of the canvas tube was entirely distinct
t of the objective and of the rail for the plate carrier,
ibration of the tube would produce no effect on the image.
vas tube was large enough for the observer to remain inside
pose the plates there, a most convenient arrangement.
ıer photographic instruments were employed, viz. the
uatorial of 6 inches aperture and 6 feet focal length a
allmeyer portrait-lens, and two cameras.

Schaeberle gives an interesting description of the voyage
ı Francisco. The port of Carrizal Bajo, where he disem-
was reached on March 9; here he was warmly received by
g, the British Consul, who gave him assistance in selecting
se station and afterwards took part in the observations.

some deliberation the mine of Mina Bronces was selected.
ude of this station is 6600 feet, and its adopted co-ordi-
$4^h\,41^m\,22^s{\cdot}5$ West of Greenwich, $28^\circ\,26'\,3''$ South. These
ained from numerous sextant observations both at Mina
and Carrizal Bajo, a chronometer being carried between
the longitude of the latter being taken from the 'Connais-
s Temps.' Full details of these observations are given in
ort.

ine was in charge of an Englishman, Capt. Bray. Prof.
le speaks very highly of the assistance rendered by him

and the other officers of the mine and says "I was quartered at Mina Bronces something over six weeks. The officers of the mine refused compensation for the services rendered by their workmen during this time, and also refused to accept any payment for board and lodging."

The weather on the day of the eclipse was perfect, "the sky being absolutely free from clouds, smoke, or haze." The observers were distributed as follows:—

| | |
|---|---|
| 40-ft. telescope ........ | J. M. Schaeberle. |
| 6-inch Clark Equat. .... | Messrs. Gale[*] and Walker[†]. |
| 6-inch Dallmeyer ...... | " King[‡] and Bray[‖]. |
| 5 × 7 camera .......... | Mr. Tirepegui. |
| 4 × 5 " .......... | " Hole[†]. |
| Timekeeper ............ | " Curmey[‖]. |
| Visual observ^ns of corona.. | " Aubertin[†]. |

Three Lieutenants of H.M.S. 'Melpomene' also gave assistance. The various observations were all carried out without a hitch. Most interesting reports from each observer are printed, and Mr. Aubertin has also published his impressions in a little volume "By order of the Sun to Chile.'

The approaching shadow of the Moon was seen for 2½ minutes before totality. The "shadow-bands" or wave-like pulsations of light and shade were very prominent some 15 seconds before totality, and seem to have been still more strongly marked at Carrizal Bajo, on the extreme limits of the zone of totality. The darkness during totality was not very striking: "the second-hand of a watch was easily seen"; "lawn-tennis could have been carried on in the light." The naked-eye aspect of the corona is stated to have been beautiful in the extreme; "the extensions in some directions exceeded two diameters of the Moon's disc"; Mr. Aubertin says of it, "exquisite in delicacy and in purity and elegance complete." Five naked-eye sketches were obtained, of which one is reproduced.

The following table shows the number of photographs obtained:—

| Instrument. | No. of photos. | Limits of exposure. |
|---|---|---|
| 40-ft. ........ | 8 | ¼ sec. to 32 sec. |
| Clark ........ | 10 | ¼ sec. to 32 sec. |
| Dallmeyer .... | 10 | ¼ sec. to 4 sec. |
| 5 × 7 ........ | 6 | 1 sec. to 32 sec. |
| 4 × 5 ........ | 18 | ¼ sec. to 32 sec. |

The plates were all developed *in situ*, distilled water being obtained from the engine of the mine.

Photographic reproductions of some of the plates are given in the Report. Those by the Dallmeyer lens show extensions of orona as far as Venus (over 4° from the Sun), while the 40-feet hotographs show much fine detail near the Sun. Standard squares vere impressed on the negatives in order to determine the relative ctinic power of different portions of the corona, and two diagrams iving the curves of equal actinic power for two of the Clark lens lates (exposure 4 seconds and 2 seconds) are given. These are ery nearly circular and concentric with the Sun.

---

[*] The well-known amateur astronomer of N.S.W.

[†] English amateurs.

[‡] The British Consul at Carrizal Bajo.

[‖] English officials of the mine.

A detailed discussion of all the prominences and coronal treamers follows. Prof. Schaeberle gives the following interesting onclusions concerning the prominences:—"All the evidence iven by the prominences therefore leads to the conclusion that his matter is in rapid motion, and that instead of rising from the Sun's surface in irregular masses, the structure is just as definite s is found to be the case in the coronal streamers. In other vords, every prominence visible during this eclipse was made up f individual streams of matter apparently moving in elliptical rbits, with the Sun in one of the foci. The almost certain con-lusion seems to be that all prominences are of the same general tructure, and that the chief cause why this structure has not been nore generally recognized is due to the want of sufficient scale nd definition, as shown by a comparison of the results obtained vith the published spectroscopic results of the uneclipsed Sun bserved on the same day by Profs. Hale and Fenye."

With regard to the corona he lays down a similar principle. 'The coronal structure of this eclipse is apparently governed hroughout by a single simple law, viz.: the matter is arranged long portions of elliptical streams, one focus of the ellipse being t the Sun's centre." A detailed examination of the several treamers follows, and Prof. Schaeberle then examines where the entres of eruption should be situated to account for the observed orms on the assumption that the above law holds. He says:— I found that for the main features practically the whole corona uld be accounted for by six eruption areas on the visible hemi-here of the Sun, located within the spot zones with such finitiveness that the direction of inclination of the solar equator s made evident."

He compares these theoretical areas of disturbance with Prof. ale's photographs on the same day, and says: "an agreement tween the observed and theoretical disturbed areas will at once recognized; the coincidence seems too close to be ascribed to re chance."

Should these views as to the structure of the corona be con-ned by subsequent eclipses, its forms would seem to be entirely plicable on a simple gravitational hypothesis, without having ourse to electrical or magnetic forces.

The comet detected on the photographs has been already alluded in these columns, a remarkable coronal streamer reaching m the Sun to it and inclined to all the other streamers in the ighbourhood. This was the immediate occasion of the publica-n of Prof. Schaeberle's paper "On a Mechanical Theory of

Comets," which accounted for the phenomena of comets' tails by impact of a coronal stream with the particles of the cometary atmosphere.

Other astronomical work done at Mina Bronces included a series of photographs of Sirius from near the zenith to near the horizon to determine the photographic absorption at different altitudes; also long-exposure photographs of the region round $\eta$ Argûs and the greater Magellanic cloud; also a series of photographs of the double star $\alpha$ Centauri, intended for measurement of distance and position-angle. These photographs have not yet been fully discussed.

On his return journey Prof. Schaeberle paid a visit to the Harvard College Observatory at Arequipa. He compares the seeing there with that on Mt. Hamilton, to the advantage of the latter. He gives a most interesting account of the ascent of the west peak of Chachani, 18,100 feet high, in the immediate neighbourhood of the observatory.

Prof. Schaeberle certainly deserves congratulation on the successful result of this expedition, which has considerably increased our knowledge of the structure and disposition of the substances forming the solar prominences and corona. A. C. D. C.

## NOTES.

Comet Notes.—W. Doberck publishes in Ast. Nach. 33[illegible]8 definitive elements of Comet 1824 I. This comet was only observed in Australia, and was visible from 1824 July 14 to Aug. 10. The places of the comparison stars have been revised, and proper motions computed and applied where possible. The final elements are:—

T = 1824 July 11·5253 Paris M.T.

$$\left.\begin{array}{ll} \omega \ldots\ldots & 334^\circ\ 6'\ 17'' \\ \Omega \ \ldots & 234\ 21\ \ 8 \\ i \ldots\ldots & 125\ 26\ 36 \end{array}\right\} 1824{\cdot}0.$$

log $q$ . 9·77208

Dr. Berberich has deduced the following elliptical elements of Swift's Comet from observations on Aug. 21, 24, 25, 28:—

T = 1895 Aug. 25·499 Berlin M.T.

$\omega$ ...... 171° 45′
$\Omega$ ...... 168 32
$i$ ...... 2 27
$\phi$ ...... 25 50
$\mu$ ...... 1101″
log $a$ .... 0·3389
Period .. 3ʸ·22

The period is still very doubtful, and Dr. Berberich thinks it will probably turn out to be about 5 or 6 years. Prof. Boss has deduced a period of 8·8 years.

The following is a rough ephemeris :—

| | R.A. | N. Decl. | | R.A. | N. Decl. |
|---|---|---|---|---|---|
| | h m s | ° ′ | | h m s | ° ′ |
| Sept. 30.. | 1 23 35 | 4 45 | Oct. 12.. | 1 25 56 | 3 59 |
| Oct. 4.. | 1 24 52 | 4 27 | 16.. | 1 25 40 | 3 52 |
| 8.. | 1 25 40 | 4 11 | | | |

Faye's Comet was observed on its return on Sept. 26 at Nice. It is described as faint. Perihelion passage takes place 1896 March 19·5.

The following ephemeris for Berlin midnight is by Herr Engström :—

| | R.A. | S. Decl. | | R.A. | S. Decl. |
|---|---|---|---|---|---|
| | h m s | ° ′ | | h m s | ° ′ |
| Oct. 5.... | 21 7 36 | 3 3 | Oct. 21.... | 21 13 0 | 4 42 |
| 9.... | 21 8 12 | 3 31 | 25.... | 21 15 42 | 5 1 |
| 13.... | 21 9 18 | 3 58 | 29.... | 21 18 48 | 5 18 |
| 17.... | 21 11 0 | 4 21 | Nov. 2.... | 21 22 18 | 5 32 |

A. C. D. C.

---

WE understand that the Crossley reflector presented to the Lick Observatory has arrived safely at Mt. Hamilton.

A small zinc box has been built into the wall of the Crossley ome. It contains a letter of Mr. Crossley, the cards of the stronomers of the Lick Observatory, the circular to visitors, a rcular of the Astronomical Society of the Pacific, a set of United tates postage-stamps of the current year and of the Columbian ear 1892.

---

THE WEATHER IN SEPTEMBER.—It appears by a telegraphic espatch "*per* Dalziel" that this has been the hottest September nown in the history of the United States. The average temerature (? daily maximum temperature) for the entire country is ated to have been 96°, and at some places the thermometer has dicated 104°!

In the United Kingdom the weather has been exceptionally fine nd very warm at times. The highest shade-temperature recorded Greenwich in the earlier part of the month was 81°·7 on the h, but this value has been exceeded on many occasions in past ears. After a period of nearly average warmth extending roughout the twelve days Sept. 11 to 22 inclusive, a burst of henomenal warmth for the time of year set in, culminating in a mperature of 87°·3 on the 24th, which is not only the highest mperature for the year 1895, but also by far the highest temrature which has been experienced at this advanced period of he year during the whole term of observation since 1841. ndeed, taking the whole month through, there are only two alues on record in excess of this extreme value, viz. that on ept. 7, 1868, when a temperature of 92°·1 was registered, and hat on Sept. 1, 1886, when it was 87°·7. The sunshine has een greatly in excess of the average amount, and rainfall in defect. The severe thunderstorm which visited London on the morning of September 7, occurring at so late a period in this remarkable season, deserves a passing notice. At Greenwich it raged principally between $4^h$ $30^m$ A.M. and $5^h$ A.M., during which time rain fell heavily with hail, producing a fall of 0·75 in. in 32 minutes, or at a rate per hour of 1·4 in. The total rainfall amounted to 0·8 in. The lightning and thunder were incessant. At Camden Town (*vide* Mr. Symons's report to 'The Times') the storm, which occurred at practically the same period as at Greenwich, gave during its progress 0·65 in. of rain, of which 0·39 in. fell in the 10 minutes between $4^h$ $20^m$ A.M. and $4^h$ $30^m$ A.M. Again, at $6^h$ $10^m$ A.M., rain fell to the amount of 0·20 in., and at $7^h$ $35^m$ A.M. 0·38 in. fell in about $15^m$, giving a total rainfall for the day of 1·24 in. This latter storm was not experienced at Greenwich, although dense clouds gathered shortly before $8^h$ A.M. and there was a single flash of lightning with thunder, but only a few drops of rain fell. At various places in Middlesex and Surrey the rainfall ranged between 1 inch and 1·5 inch, whilst in Hampshire the rainfall appears to have been much larger. W. C. N.

---

THE statement ('Observatory,' p. 317) with regard to the defective equipment *re* rain-gauges of the new Brussels Observatory, extracted from 'Symons's Monthly Meteorological Magazine,' we learn (by the September number of the same journal) was based upon a misconception, and we regret that we have inadvertently been the means of spreading this error. It appears from an explanation by M. Lancaster to Mr. Symons that at Brussels there are two self-recording rain-gauges.

---

SIR H. GRUBB has issued a new 'Illustrated Catalogue of Astronomical Instruments, Observatories, &c., &c.,' in a form and cover worthy the nature of the contents. Accompanying the sketches of instruments are a number of reproductions of photographs taken with them.

In general these are carefully done, especially the frontispiece "Photograph of η Argus and surroundings"—which adds value to the catalogue; but in the reproduction of the photograph of the Pleiades, taken with the Greenwich Astrographic Telescope, the corners of the réseau alone are visible, and so give the appearance of some hundreds of stars equally distributed over the whole area of the photograph, and thus entirely spoiling the effect.

This is the more to be regretted as no photograph of the 28-inch is included—the latest and largest of Grubb's make.

---

DR. T. J. SEE has investigated the orbit of γ Virginis, and determines the following elements:—

| | | | |
|---|---|---|---|
| P .... | 194·0 years | T .... | 1836·53 |
| $e$ .... | 0·8974 | ☊ .... | 50°·4 |
| $a$ .... | 3″·989 | $i$ .... | 31 ·0 |
| $\eta$ .... | −1°·8557 | $\lambda$ .... | 270 ·0 |

The place for 1895·3 is $p=331^\circ\cdot3$ and $\rho=5''\cdot84$.

A RE-DETERMINATION of the orbit of $\mu^2$ Böotis, $\Sigma$ 1839, also by Dr. See, gives the following elements :—

| | | | |
|---|---|---|---|
| P .... | 219·42 years. | T .... | 1865·30 |
| *e* .... | 0·537 | ☊ .... | 163°·8 |
| *a* .... | 1″·268 | *i* .... | 43 ·9 |
| $\eta$ .... | − 1°·6407 | $\lambda$ ... | 329 ·75 |

This period is considerably shorter than determined by Doberck (1878) and Pritchard (1878), and the positive residuals in position-angle are rather in excess; but in all probability we now know the period within 10 years.

As this binary is a fairly easy object for a 6-inch, we give the following ephemeris, according to See :—

| | | |
|---|---|---|
| 1896·5 ...... | 81°·1 | 0″·85 |
| 1897·5 ...... | 78 ·9 | 0 ·86 |
| 1898·5 ...... | 76 ·9 | 0 ·87 |

---

MR. W. W. CAMPBELL has made a careful deduction of the diameter of Mars from observations made at Mt. Hamilton in 1894 and 1895, with the 36-inch equatorial. He gives the following table of previous determinations for comparison :—

| Observer. | Date. | Method. | Polar diameter. |
|---|---|---|---|
| Arago...... | 1813 | Rochon micrometer. | 9″·167 |
| Bessel...... | 1830–37 | Heliometer ...... | 9 ·342 |
| Kaiser .... | 1862–65 | Airy's micrometer.. | 9 ·375 |
| Main ...... | 1862–63 | Heliometer ...... | 9 ·304 |
| Hartwig.... | 1877–78 | Heliometer ...... | 9 ·300 |
| Campbell .. | 1894–95 | Filar micrometer .. | 9 ·254 |

Adopting Prof. Young's value of the polar compression, $\frac{1}{219}$, the equatorial diameter resulting from the Lick measures is 9″·30.

---

PROF. C. L. DOOLITTLE has been appointed Director of the new Observatory at the University of Pennsylvania, which is equipped with an 18-inch equatorial, a 4-inch zenith telescope, and a 3-inch prism transit.

AFTER 1895 Oct. 1 Prof. E. E. Barnard's address will be Yerkes Observatory, Lake Geneva, Wisconsin.

## FROM AN OXFORD NOTE-BOOK.

MENTION has been already made in these notes of the difficulty which the average man seems to find in grasping elementary mathematical notions. Indeed he generally does not make the effort at all, preferring to regard them as the legitimate province of those technically instructed. If there be a sum in simple addition to be done, and a mathematician is present, his aid is invoked; and, however jestingly, there is a touch of earnestness about the appeal. The following story is told of Prof. Chrystal :—When working at the black-board, a mischievous student dropped a marble which slowly rolled from one step to another of the raised benches, and finally to the floor; whereupon the lecturer, who had not turned round, called upon the student at the end of bench 10 to stand up. He had counted the stairs; and there are few of us unequal to this simple operation and inference; but usually, in relating the story, the implication is subtly conveyed that it was mathematical knowledge alone which rendered the accomplishment possible.

THE average man draws the line at what mathematical knowledge should be expected of him at some rather elementary stage, which it is not easy to specify exactly, but which is apparently on the safe side of decimals. One or two of our leading newspapers, in dealing with cricket averages, have recently made a heroic effort and introduced decimals. But the practice is by no means universal. Here are the first two lines from the list of Batting Averages of Mr. Stoddart's team in Australia, as given in 'The Globe' of 1895 March 6:—

| | No. Inns. | Total Runs. | Average. |
|---|---|---|---|
| A. E. Stoddart.... | 17 | 870 | 51·3 |
| A. C. McLaren.... | 14 | 726 | 51·12 |

[To avoid complication the quotation is not literal, the times not out having been subtracted from the number of innings and the highest scores omitted; but the averages are reproduced as printed.] For those who know nothing about cricket I may say that the operation required is the division of 870 by 17, and of 726 by 14, which would give 51·18 and 51·86 respectively, the second average being the greater. But instead of these figures there are set down 51·3 denoting 51 and 3 over; and 51·12 denoting 51 and 12 over; the compiler of the statistics not being equal to any further exertion. Not only is the result incomplete, but absolutely misleading: for some vague glimmerings of the value of decimals have caused 51·3 to be placed before 51·12.

THE astronomical bearing of the previous two paragraphs is perhaps not very clear, and even the explanation of the present paragraph may not be accepted. But I wished to lead up to the remark, by however devious a route, that something of the same reluctance to attend to exact mathematical principles of an elementary nature is often traceable in scientific work. It generally takes the form of a vagueness as to how many figures shall be used in a result. Indeed nearly all forms of mathematical slovenliness, sometimes amounting to inaccuracy, may be ultimately traced to this form. Take, for instance, the following sentence from a paper recently printed:—

"In three experiments equality was attained when the ratios of the squares of the distances of B from C and D from C respectively were 1 : 3·6, 1 : 4¼, and 1 : 3·36."

Here there is no actual mistake: but three ratios which ought to be strictly comparable are expressed in three different ways. Any of the forms for the second term 3·6, 4·3, 3·4; or $3\frac{2}{3}$, $4\frac{1}{3}$, $3\frac{1}{3}$; or 3·60, 4·33, 3·36 would be admissible; but they all imply essentially different methods of obtaining the figures, whereas the experiments are represented as comparable and similar.

THIS vagueness about how many figures to use is unfortunately too common, and is responsible for much wasted labour. It has been assumed throughout the history of Astronomy that "figures are cheap": that, once an observation is made, computing labour may be lavishly spent on it. One result of this assumption has been the accumulation of observations which will never be reduced, though it may seem paradoxical to say so; nevertheless, it is clear that there should be an established ratio between the time spent in making an observation and the time spent in reducing it; and if too heavy a programme of numerical work be adopted, it will hang fire and perhaps come to nothing at all. Is it not time to protest against this lavish waste of figures? Many instances might be given in illustration, but would be out of place in these brief notes. I hope I shall not be thought to be making a personal attack in quoting one only: I choose it because it is epresentative and not exceptional.

IN the Introduction to the Radcliffe Catalogue (1890), p. vii, s given the following illustration of the computation of a star orrection in R.A.:—

1890 Feb. 18. 68 Geminorum: R.A. $7^{h}\ 27^{m}\ 25^{s}$, N.P.D. 73° 56′.

| | *a.* | *b.* | *c.* | *d.* | *Sc.* |
|---|---|---|---|---|---|
| A. Table...... | 9·57122 | 9·96755 | 9·96755 | 9·57122 | |
| P.D. Table...... | −8·84121 | +8·84121 | +9·58551 | −8·28331 | +0·4875 |
| ay Numbers...... | −1·2122 | +1·0050 | −9·2670 | −9·5786 | −9·2670 |
| | +9·6246 | +9·8138 | −8·8201 | +7·4331 | −9·7545 |
| | +0·421 | +0·651 | −0·066 | +0·003 | −0·568 |

$$\text{Corr.} = \left\{ \begin{matrix} +1\cdot075 \\ -0\cdot634 \end{matrix} \right\} = +0^{s}\cdot44.$$

Here, to get a result of 2 or 3 figures, a start is made with -figure logs. The Day numbers are only given to 4 places, and et the others are entered to 5, so as to be sure of having the ourth place correct. Theoretically, this is a carefulness worthy f commendation; practically, one cannot but remark, firstly, that f by restricting the calculation to a few less figures, or doing it iagrammatically, the final correction had been found $+0^{s}\cdot45$ or $+0^{s}\cdot41$ even, such errors might be treated as accidental; secondly, hat such carefulness is seldom consistently carried through the omputation, and hence not of much value in a single step. In he present case the Day numbers apply to Greenwich midnight, nd require a correction for the longitude of Oxford and the time

of meridian passage of the star, which would alter them in th
third place: so that it is useless to trouble about the fourth.

THE many friends and admirers of Dr. B. A. Gould will lear
with the deepest concern of a severe accident which befel him i
June last. As he was walking, in a leisurely manner, in one
the principal streets of Boston, a frightened horse with wago
attached ran upon the sidewalk and severely injured several fo
passengers, of whom the veteran astronomer was unfortunatel
one. For many weeks Dr. Gould was confined to bed, and, indee
for some time almost unable to move. I am glad to be ab
to add that he is, however, now progressing favourably towar
recovery, and can get from one room to another, though he ha
not at the time I last heard from him (Sept. 2) yet been able t
wear a boot. What made the accident more serious was tha
Dr. Gould was just recovering from a sharp attack of influenz
It is characteristic of his great energy and determination that h
managed in, spite of all, to carry on the editorship of the *Astr*
*nomical Journal* as usual.

THERE will doubtless be many visitors to Norway next year
see the Total Solar Eclipse. It is not often that the necessa
journey is so short. Messrs. Anderson and Anderson are early
the field with a programme of arrangements, including seven da
at Vadsö for seeing the eclipse, which ought to suit even tho
who propose to take out apparatus for which adjustment is nece-
sary. Those with hand cameras or other simple apparatus m
even find the time at Vadsö a little long. The cost per head
apparently to be forty guineas, a sum fairly within the resour
of many.

IT is to be hoped that suggestions will be forthcoming for t
organization of the large amount of skilled labour that will
available on the occasion. The real work of an eclipse
undoubtedly the obtaining of photographs of the corona and
spectrum: the important things to be done have been gradua
narrowed down to these almost entirely. But there are ma
points of minor interest worthy of careful attention; a study
the compilation by the late Mr. Ranyard in Mem. R. A. S. vol. x
will suggest many. Take, for instance, the question of the *gener*
brightness of the corona, on which information is very vagu
The estimates have been hitherto of a rough kind, such as wheth
it was possible to read small print; this must depend on what t
eye was doing before, whether gazing at the Sun or not. With
camera something more scientific could be determined. Exposur
on some object could be compared with others made at twilig
(on definite dates at definite times). The details should be car
fully thought and worked out beforehand, but the investigation
well within the reach of anyone with a hand camera and a watc

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 233. NOVEMBER. 1895.

## *The Dimensions of Saturn's Ring.*

In an elaborate paper, "Sur les dimensions des Anneaux de Saturne,"* read before the Academy of Sciences in November 1851, M. Otto Struve contended that the outer diameter of the Ring System of Saturn remained perceptibly constant, but the inner diameter was gradually decreasing—in other words, that the whole ring was spreading inwards and narrowing the space between the ring and the planet. This theory has been introduced into our text-books in some instances as an established fact and in others in such a way as to lead to a belief in its reality †, and this notwithstanding that astronomers have looked at it askance because of the nature of the evidence on which it was based. There are not an abundance of measures of the system even now, yet the accordance of recent measures ‡ of Saturn and his rings induces us to use them in a re-investigation of Struve's theory; and with this end in view it is proposed first to give a short *résumé* of M. Struve's pamphlet, which may not be within reach of all, as an easy mode of placing the matter before us.

M. Struve's investigation depends largely on a discussion of early observations made by Huyghens and Cassini. After remarking that it was not till 1656 that Huyghens discovered the true nature of the appendages to Saturn, and of the uselessness of endeavouring to extract information from previous records, he treats this observer's notes as follows:—

"*Huyghens*, in his *Systema Saturnium*, published in 1659, says:—'*Latitudinem vero spatii inter annulum globumque Saturni interjecti, æquare ipsius annuli latitudinem vel excedere etiam, figura Saturnii ab aliis observata, certiusque deinde quæ mihi ipsi conspecta*

---

* 'Mémoires de l'Académie des Sciences de St. Pétersbourg,' vi. série, Sciences mathématiques et physiques, tome v.

† Proctor boldly adopts; Newcomb introduces it without denial. It has been used by Maxwell and Hirn in their investigations of the construction of Saturn's rings.

‡ At Washington with 26-inch, Lick with 36-inch, Greenwich with 28-inch.

*fuit, edocuit: maximamque item annuli diametrum eam circiter rationem habere ad diametrum Saturni quæ est 9 ad 4.'*"

Now Huyghens also made the distance of Titan at greatest elongation = 3′ 20″, and noted that this distance was to the diameter of the ring as 4 to 1; and Newton[*] deduced from this 50″ as the diameter of the ring and 11″ as the semi-diameter of the planet, which he corrected by 2″ or 3″ for irradiation[†], thus finding 9″ as the semi-diameter of Saturn.

Huyghens also measured directly the diameter of the ring =68″, when Saturn was at its least distance from the Earth. Now he made the diameter of Jupiter at maximum =64″, while we know it to be 47″·5, hence he was in error 16″·5. Assuming the same error made in his measure of Saturn's ring, we get 68″−16″·5=51″·5, or at *mean distance* 46″.

To deduce results from these data M. Struve assumes *two constants*, viz.:

| | |
|---|---|
| Outer diameter of Ring.... | 40″·00 |
| Eq. diameter of Planet .... | 17 ·80 |

The distance, then, from the limb of the planet to the outer edge of the ring is 11″·1, which halved gives

| | |
|---|---|
| Breadth of ring........ | 5″·55 |
| Width of space........ | 5 ·55 |

But when the correction for irradiation, viz. 2″, is applied,

| | |
|---|---|
| Breadth of ring........ | 1″·55 |
| Width of space........ | 9 ·55 |

A value so small for the ring as to make it doubtful whether the ring could have been seen throughout its whole extent with the feeble telescope of Huyghens; so M. Struve supposes that Newton must have exaggerated the effect of irradiation, and "Je la suppose quatre fois plus petite que la plus petite valeur estimé par Newton, ou d'une demie-seconde." Then

| | |
|---|---|
| Breadth of ring........ | 4″·60 |
| Width of space........ | 6 ·50 |

Again, in 1698, in his *Cosmothéoros*, Huyghens omits the words "vel excedere etiam," using instead "Vacuum spatium inter utrumque interjectum, eandum quam annulis latitudinem habebit"; and hence M. Struve argues:

| | |
|---|---|
| Breadth of ring........ | 5″·10 |
| Width of space........ | 6 ·00 |

Respecting the supposed measures of Cassini, M. Struve says:—"We read in 'l'Histoire de l'Académie des Sciences' (année 1715, p. 45) that 'la circonférence extérieure de l'anneau est élevée de plus de 18000 lieues au dessus de la surface de Saturne,' and further, "que cet anneau a une largeur de plus de 8000 lieues.'" Admitting the correctness of these numbers, I obtain the ratio of the space to ring as 5 : 4, or

---

[*] Philosophiæ naturalis Principia, ed. Cotes. Cantabrigiæ, 1713, lib. iii. prop. viii.

[†] (Subducatur lux erratica quæ haud minor esse solet quæ 2″ vel 3″.)

Breadth of ring........ 4″·90
Width of space........ 6 ·20

These numbers are uncorrected for irradiation, and are thus left because (1) they can only be regarded as approximate; (2) the epoch is uncertain; (3) their origin is not known; (4) "et il serait même possible que la largeur de 8000 lieues soit provenue de la combinaison du diamètre extérieur mesuré en 1691 par J. D. Cassini avec les observations de Huyghens, publiées dans le *Systema Saturnium*."

*Bradley's* measures were made with a Townley micrometer and are extremely good. He obtained in 1719:—

Diameter (exterior) of ring .... 41″·17
„ (interior) of ring .... 28 ·10
„ (equatorial) of planet.. 17 ·64

Hence Breadth of ring........ 6″·53
Width of space........ 5 ·23

*Newton* allowed one second for effect of irradiation; but this is too large, and M. Struve divides it as before by 4, and uses 0″·25, and hence obtains corrected values of

Breadth of ring........ 6″·03
Width of space........ 5 ·73

M. Struve then tabulates these corrected results and others, as below:—

| | | Space. | Ring. | $\frac{\text{Space}}{\text{Ring}}$. |
|---|---|---|---|---|
| | | ″ | ″ | ″ |
| Huyghens ...................... | 1657 | 6·5 | 4·6 | 1·41 |
| Huyghens and Cassini ...... | 1695 | 6·0 | 5·1 | 1·18 |
| Bradley ......................... | 1719 | 5·4 | 5·7 | 0·95 |
| W. Herschel ..................... | 1799 | 5·12 | 5·98 | 0·86 |
| W. Struve ....................... | 1826 | 4·36 | 6·74 | 0·64 |
| Encke and Galle ............ | 1838 | 4·04 | 7·06 | 0·57 |
| O. Struve ...................... | 1851 | 3·67 | 7·43 | 0·49 |

And deduces an annual approach of the ring to the limb of the planet of 0″·013, or at mean distance 12·4 miles *.

M. Struve's remarks on the later measures are omitted because he has used them unaltered. This theory is attractive as it accor[illegible]s with mechanical laws, and inspection of the above table is enou[illegible]h to satisfy the casual reader of its truth; but, in the first place, t[illegible]e construction of the table is doubtful, the doubt being in the adopt[illegible]d value of the irradiation. According to the table, the whole chan[illegible]e in either column for two centuries is under 3″; and here we a[illegible]re correcting for quantities which may be 6″ or 4″ (two limbs), [illegible]or they may be 1″, or they may differ little from the values a[illegible]pplicable to later measures. Because of the assumption of t[illegible]o constants, the sum of the values of space and ring is consta[illegible]t, viz. 11″·1, and this to the aforesaid casual reader gives a fictiti[illegible]us value to the table. Let us look again at the observations of Huyghens, or rather at the method in which M. Struve h[illegible]as treated them.

---

* In 1882 M. O. Struve made a further set of measures to test this, which did not verify the annual approach of 0″·013. The approach from 1851–82 was 0″·04 instead of 0″·4.

Granting diameter of Ring = 50″,
and of Planet = 22·2,

it is evident that ½(50″−22″·1), or 13″·95, gives the whole dista[illegible]ce from the limb of the planet to the outer edge of the ring qu[illegible]ite independent of irradiation; and, as a matter of arithmetic, it is t[illegible]his 13″·95 which has to be divided into equal parts, and *not* the c[illegible]onstant 11″·1. This gives us, after correcting for irradiation ([illegible]″) for each bright edge,

| | |
|---|---|
| Breadth of ring ........ | 3″ |
| Width of space ........ | 11 |

a value for the breadth of ring which would not have led M. Str[illegible]ve to reduce the irradiation. Of course, if required, we may [illegible]ow reduce to the standard 11″·1, and obtain

| | |
|---|---|
| Breadth of ring ........ | 2″·4 |
| Width of space ....... | 8·8 nearly. |

M. Struve ignores the effect of the correction on the value [illegible]of the diameters of the system, which he gives in a final table of [illegible]ollected results. In fact, if we apply the large correction we ar[illegible]ive at an absurdity, and if we apply the small one the original obser[illegible]ations of diameters do not range well. The proper course se[illegible]ms to be to discard them altogether. M. Struve's own critici[illegible]ns render any further remarks on the observations of Cassini [illegible]nd the later ones of Huyghens superfluous, and it would seem b[illegible]st to let Bradley's observations stand without correction of any k[illegible]d. Indeed, to make the most of the facts collected by M. Otto Str[illegible]ve, the best course appears to avoid irradiation altogether and to attack the observations in a different manner.

Huyghens used a very primitive micrometer, and the value [illegible]of his standard space may have been considerably in error. [illegible]ow there is the quantity 13″·95, which is independent of irradiati[illegible]r, and it ought to be 11″·2, or his values ought to be reduced by [illegible]h. Applying this to the direct measure of Saturn's ring we obt[illegible]in 68″−13″·6=54″·4, or 48″·5 at mean distance. On taking [illegible]le an distance of Jupiter's diameter we obtain 64″−13″=51″. th these results are fairly good. Other suppositions could be le, but it is not proposed to pursue this line of argument ther, and, indeed, this is only inserted that the precarious ure of the material might be appreciated.

But if the observations of Huyghens are thus set aside, the ole argument fails; and this induced us to make a more careful dy of the 'Systema Saturnium,' which appears to have repaid trouble involved.

he paucity of notes seemed out of all proportion to the wealth diagrams, and gave the impression that these latter were nded to represent the observer's ideas with considerable uracy. A further examination, indeed, made it clear that they been carefully drawn from data not printed—probably from es and figures made at the telescope but worked up afterwards. results of measurements of the diagrams are here given, and sed on the supposition that the diameter of the planet has nained constant and in value 17″·75.

Huyghens.—'Systema Saturnium.'

Page 11.—1656, March 26, on the same evening as he first suspected Titan to be a satellite, he gives a drawing of Saturn in which the ring is clearly shown. Measurements give:—

| | |
|---|---|
| Diameter of ring (outer).... | 3·04 inches. |
| „ „ (inner).... | 2·06 „ |
| „ Planet ........ | 1·37 „ |

Page 18.—1656, Oct. 13, is a similar drawing giving similar values.

Page 21.—1657, Dec. 17, is a fine drawing made with great care:—

| | |
|---|---|
| Diameter of ring (outer).... | 3·03 inches. |
| „ „ (inner).... | 2·24 „ |
| „ Planet ........ | 1·37 „ |

Page 24.—1657, Feb. 6:—

| | |
|---|---|
| Diameter of ring (outer).... | 3·03 inches. |
| „ „ (inner).... | 2·22 „ |
| „ Planet ........ | 1·36 „ |

Page 45.—1656, March 25, an elaborate drawing:—

| | |
|---|---|
| Diameter of ring (outer).... | 3·10 inches. |
| „ „ (inner).... | 2·20 „ |
| „ Planet ........ | 1·39 „ |

On this evening also is the note: "Latitudinem vero spatii ter annulum globumque Saturni interjecti, æquare ipsius annuli itudinem vel excedere etiam: maximamque item annuli diameum eam circiter rationem habere ad diametrum Saturni est quæ ad 4."

Page 55:—

| | |
|---|---|
| Diameter of ring (outer).... | 3·10 inches. |
| „ „ (inner).... | 2·23 „ |
| „ Planet........ | 1·36 „ |

Page 77.—Saturn's ring at maximum distance from the Earth subtends an angle of 68″.

The Sun an angle of 30′ 30″, and Venus 8[illegible]5″.

Jupiter at minimum distance subtends an angle of 64″.

Collecting these results and reducing to seconds of arc:—

| Date. | Diameter of ring. | Diameter of planet. | Breadth of ring. | Width of space. |
|---|---|---|---|---|
| | ″ | ″ | ″ | ″ |
| 1656 March 25 ............... | 39·68 | 17·75 | 5·76 | 5·25 |
| March 26 ............... | 39·40 | 17·75 | 6·35 | 4·54 |
| Oct. 13 ............... | 39·40 | 17·75 | 6·35 | 4·54 |
| Dec. 17 ............... | 39·40 | 17·75 | 5·18 | 5·70 |
| 1657 Feb. 6............... | 39·40 | 17·75 | 5·21 | 5·60 |
| .............................. | 40·30 | 17·75 | 5·70 | 5·70 |
| Mean ............... | 39·60 | 17·75 | 5·80 | 5·23 |
| * ............... | 39·94 | 17·75 | 5·55 | 5·55 |
| ** ............... | 39·94 | 17·75 | 5·92 | 5·18 |

These figures show the results of his notes:

* Assuming 17″·75 as diameter, and making the diameter of ring $\frac{9}{4}$ diameter of planet, and the space = breadth of ring.

** Assuming 17″·75 as diameter, and making the diameter of ring $\frac{9}{4}$ [illegible] diameter of planet, and the breadth of ring = $\frac{1}{3}$ diameter of planet.

If, now, we give equal weight to these notes and to each drawing, we get:—

| | |
|---|---|
| Diameter of ring........ | 39″·66. |
| Breadth of ring ........ | 5 ·76. |
| Width of space ........ | 5 ·26. |

Using these values for Huyghens in 1656, omitting altogether his later note and the supposed observations of Cassini, and adopting Bradley's observations without any change, we can commence a new table. It has been endeavoured to make this table as complete as possible, so that if by chance any observations have been overlooked, it may be put down to the great difficulty and time required to collect such facts. In any case no material alteration can be made in the table, from which it will be seen that the most probable values are:—

| Breadth of Ring. | Width of Space. | $\frac{\text{Space.}}{\text{Ring.}}$ |
|---|---|---|
| 7″·3 | 4″·0 | 0·55 |

No constant change can be detected in the ratio $\frac{\text{space}}{\text{ring}}$, and so M. Otto Struve's theory must certainly be abandoned. One would, however, scarcely venture to say that changes do not occur either of a periodic nature or otherwise, as the observations are by no means accordant; but this may be accounted for by the great difficulty in making these measures, and this view is borne out by the greater accordance of recent measures with powerful instruments:—

| Observer. | Date. | Breadth of ring. | Width of space. | $\frac{\text{Space}}{\text{Ring}}$. |
|---|---|---|---|---|
| Huyghens | 1656 | ″5·76 | ″5·26 | 0·91 |
| Bradley | 1719 | 6·53 | 5·17 | 0·79 |
| W. Herschel | 1799 | 5·98 | 5·12 | 0·86 |
| W. Struve | 1826 | 6·73 | 4·34 | 0·65 |
| J. Herschel and South | 1828 | 7·76 | 3·57 | 0·47 |
| Encke | 1837 | 6·85 | 4·62 | 0·67 |
| „ | 1838 | 7·39 | 4·24 | 0·57 |
| Galle | 1838 | 6·50 | 4·23 | 0·65 |
| Bond | 1848 | 6·96 | 3·62 | 0·66 |
| O. Struve | 1851 | 7·43 | 3·67 | 0·49 |
| R. Main | 1853 | 6·41 | 5·14 | 0·80* |
| Jacob | 1853 | 6·80 | 4·18 | 0·61 |
| R. Main | 1854 | 6·35 | 5·46 | 0·86* |
| De la Rue | 1854 | 6·46 | 4·63 | 0·71 |
| Secchi | 1855 | 7·55 | 4·03 | 0·53 |
| „ | 1856 | 7·18 | 4·30 | 0·59 |
| Jacob | 1856 | 6·87 | 4·14 | 0·60 |
| Kaiser | 1865 | 5·81 | 5·50 | 0·95* |
| Meyer | 1880 | 7·08 | 4·42 | 0·62 |
| „ | 1881 | 7·18 | 4·14 | 0·57 |
| O. Struve | 1882 | 7·53 | 3·67 | 0·48 |
| Hall | 1885 | 7·35 | 4·02 | 0·55 |
| Barnard | 1894 | 7·36 | 3·89 | 0·53 |
| Dyson | 1895 | 7·77 | 3·54 | 0·46 |
| Lewis | 1895 | 7·37 | 4·11 | 0·55 |

While collecting the material for the foregoing table, I was surprised at the few really good sets of measures of Saturn and its rings, and thought a tabulated statement of all the results I could find would serve not only for reference, but as an inducement for observers to pay some attention to the micrometric measurement of the system †. Evidently there is little fear of wasting time in such work, as the collected results will show. It may very well be that a few are left out, and if these are noted and sent to the Editors they will be at once published, so that they may be interpolated in the table. Unfortunately Saturn is badly situated at present for high latitudes. T. Lewis.

---

* The observations of Main and Kaiser were made with a double-image micrometer.

† This table will be published in a subsequent number.

## *On the Probable Errors of Meridian Observations in Declination.*

Prof. T. H. Safford, of Massachusetts, in the course of the work of preparing a catalogue of stars, has had to face the question of relative weights of different authorities in declination. He has prepared a memoir on the subject, which is now in the press; but for the present he publishes a note in the 'Astronomical Journal,' No. 355, on the probable error of single meridian observations, which we should have liked to have printed in full, but its length compels us to be content with copious extracts.

Prof. Safford begins by referring to Gyldén's memoir* on the subject, in which the probable error ($v_1$) of an observation is expressed by the radical $\sqrt{\sigma^2+\rho^2+\zeta^2}$, where $\sigma$ is the probable error of setting and reading off, $\rho$ the probable error of the computed refraction, and $\zeta$ the probable error of the zenith-point; and then on the obvious principle that in order to diminish the probable error of an observed declination the effort should be made to diminish the separate elements, he goes on to discuss how this may be done.

The Poulkova standard zenith-distances, which form the basis of Gyldén's memoir, are measured with an altazimuth. With such an instrument the quantity $\zeta$ is much diminished by immediate reversal of the instrument, that is, by making a half-rotation about a vertical axis, and then making a second observation of the star. By such a double observation Prof. Gyldén found that $\zeta$ was diminished from 0″·30 to 0″·11, and at the same time in the above formula for $v_1$, $\sigma^2$ is replaced by $\frac{1}{2}\sigma^2$.

To diminish $\rho$, which depends on irregular variation of the actual refraction from that computed from the indication of the meteorological instruments, Prof. Safford implies that the best method is to use the observations of well-determined standard stars as a check on observed declinations. He points to Becker's catalogue of 521 Bradley stars (Berlin, 1881), where the quantity $\rho$ has been made almost entirely to disappear. This was accomplished by employing a relatively large number of standard stars thoroughly interwoven with the stars to be determined similarly to the method adopted for the *Astronomische Gesellschaft* great catalogue. But the writer is careful to say "that it must be remembered that the casual errors of the standard catalogue pass over into systematic and constant errors in the more numerous star-places determined from them." Further, in computing $\rho$ from a series of observations, Prof. Safford thinks it only fair, for well-known reasons, not to use the observations near the horizon.

As to the quantity $\sigma$, this can of course be diminished by more settings and readings off and by the exercise of care generally, and equally, of course, it depends on the instrument itself. In this connection Prof. Safford makes some instructive remarks:—

---

* 'Observations de Poulkova,' vol. v.

"The size of an instrument has a well-defined influence on its accuracy, but one which is less marked than is usually supposed. A large meridian circle does not of itself produce accurate results, nor a small one those which are seriously inaccurate. Two marked examples of good work are the observations of Professor Valentiner at Karlsruhe and Professor Becker at Gotha. The former was placed in charge of the old and defective observatory at Mannheim. After removal to a temporary building at Karlsruhe, he employed a Reichenbach repeating-circle reconstructed into a meridian circle, with 3¼-in. aperture; his single observations at a zenith-distance of 50° and more have a probable error of $\pm 0''\cdot 40$. Becker completed, with a small and old circle at Gotha, the re-observation of Mayer's stars not in Bradley; this is well known to all who have read Professor Auwers's admirable edition of Mayer, as an excellent and thoroughly accurate piece of work, hardly second in importance and precision to his catalogue of Bradley's neglected stars.

"The extreme accuracy of the zenith telescope in Wanschaff's construction is also a proof that an object-glass of 3 inches in aperture, even with the shorter focal length now in fashion, is not too small to produce extremely precise results; and that the repetition of bisections at the same culmination allows an increase of accuracy and a diminution of the quantity denoted by $\sigma$ in Gyldén's memoir.

"All things considered, the most useful meridian circle is probably one of about 12 cm. in aperture and 1·5 m. of focal length; but constructed in such a manner with central illumination of field and limb that no additional error shall arise or be made possible thereby. The original construction of the great Washington circle, like that of the Leyden one, is faulty in this point; and in both cases anomalous results have been noticed, and the precision attained has been at times far below that which is desirable. It seems possible, however, by continual watching of the focal adjustments, greatly to mitigate this evil; the larger Berlin meridian circle seems to have been used by Becker in the same condition, and the fault corrected in current work; the later reconstruction of the Berlin and Leyden instruments renders it easier to obtain precise results, which before was not impossible, but merely difficult. Foerster had investigated the whole problem of the illumination of micrometer-points, and it is to be presumed that his researches were available.

"We can now understand Prof. Kaiser's disappointment at the lack in precision of his great series of declinations. This seems to be entirely accidental, and confined to the individual observations; and the especial point which attracted his attention was the wide variations as to probable error between different stars and different observers. With 16 observations to a star, the probable error of the probable error would be $\frac{0{\cdot}476}{\sqrt{15}} = 0{\cdot}12$ of the probable error [illegible] itself. The fact that this amount was exceeded by the comparison *inter se* of the probable errors of individual stars indicates of course that the latter actually varied from time to time in th[illegible]e series. In other words, when the focal adjustment was bad, owing to change of temperature or other accidental causes, the probable error of a declination would be large; while it would be small if the focal plane of the object-glass returned nearly to the plane of the wires.

"We now, thanks to Foerster's investigation, know that a perfectly central illumination relieves us from extreme anxiety about the focal adjustments; but we do not yet know the effect on probable errors of a disregard of this principle."

Prof. Safford's note concludes with a list of "the most available values of the probable error of a single declination at the zenith-distance 45°; zone observations are here omitted, so that the probable error is one which corresponds to thoroughly deliberate work.

"Class 1. Mural quadrants:

| | | | |
|---|---|---|---|
| Bradley...... | ±0″·81 | Mayer........ | ±0″·93 |

"Class 2. Reichenbach circles with verniers:

| | | | |
|---|---|---|---|
| Bessel ...... | ±0″·71 | Argelander .... | ±0″·96 |
| Struve ...... | ±0 ·60 | Preuss........ | ±0 ·82 |
| Doellen.......... | ±1″·07 | | |

"The last value is large, probably because the limbs were tarnished by long use; a circumstance which naturally affects vernie[illegible]le readings far more than microscopic. The observations were made [illegible] half a century ago at the beginning of Doellen's long and admirable experience.

"Class 3. Mural circles:

| | | | |
|---|---|---|---|
| Pond-Olufsen .. | ±0″·54 | Challis............ | ±0″·56 |
| Pond-Chandler .. | ±0 ·47 | Henderson, 1834–37. | ±0 ·50 |
| Paris, 1852 (Laugier).... | ±0″·42 | | |

"Class 4. English meridian circles before 1850:

| | |
|---|---|
| Armagh.... | ±0″·89. |

"Class 5. English meridian circles (Airy's construction):

| | | | |
|---|---|---|---|
| Greenwich (Marth). | ±0″·64 | Cape of Good Hope. | ±0″·51 |
| Greenwich (Stone). | ±0 ·60 | Radcliffe (Stone).... | ±0 ·5 |

"Class 6. German and American meridian circles with microscopes:

| | | | |
|---|---|---|---|
| **Bessel** ........ | ±0″·55 | Romberg .......... | ±0″·31 |
| Sabler ........ | ±0 ·52 | Becker ............ | ±0 ·28 |
| Doellen ........ | ±0 ·50 | Valentiner ........ | ±0 ·40 |
| Winnecke ...... | ±0 ·49 | Küstner .......... | ±0 ·28 |
| Leyden ........ | ±0 ·50 | Brown and Flint.... | ±0 ·36 |
| Engelmann .... | ±0 ·46 | Battermann........ | ±0 ·35 |

Porter........ ±0″·55.

"Class 7. The Pulkowa vertical circle:

| | | | |
|---|---|---|---|
| Peters, double obs. | ±0″·28 | Nyrén, '72, double obs. | ±0″·29 |
| Gyldén, " " | ±0 ·23 | Nyrén, '85, " " | ±0 ·23 |

"It is to be noted that the numbers given for Engelmann, Romberg, Becker, Valentiner, Küstner, Battermann, and Porter refer to relative observations; in the first two and the last cases, however, the zero-stars are spread over a large range of zenith-distance; and Valentiner had an exceptionally small instrument."

---

## *Selenographical Notes.*

Lubiniezky and the Neighbourhood.—This formation is one of the most notable examples of a comparatively large ring with very attenuated walls of insignificant altitude, enclosing a level area apparently devoid of appreciable detail. Except under a low Sun, it figures as a mere scar on the surface of the surrounding plain north of Bullialdus. Resembling in many respects the somewhat larger circle, Kies, on the southern side of the latter object, the rampart of Lubiniezky is, however, much less broken, exhibiting only six or seven small openings, the most prominent of which is on the west, on the northern side of the highest peak, which, according to Neison, rises only 985 feet above the floor. Four other gaps lie close together on the south, and a fifth, only traceable with difficulty, on the north-east. These features are omitted in all the maps, nor can I trace them in any photograph, but their existence is confirmed by an excellent drawing on a large scale made, 1890, Oct. 23, by Lieut. P. B. Molesworth, R.E. A bright spur from the north-west wall connects the ring with the bright crater D, on the west side of which Schmidt draws a long straight tapering ridge, which I have never been able to distinguish. An equally brilliant and more massive projection proceeds from the north wall, east of the first, towards the rugged region lying between the ring and Lubiniezky B. The latter is a very noteworthy object at sunrise, both on account of its brilliancy and its surroundings. This also has a very long bright spur or buttress on the south, and a conspicuous gap in its wall on the north-east, which appears to have been overlooked. An isolated mountain peak immediately north of B is of great altitude, its shadow, even when sunrise has considerably advanced, extending further east than Lubiniezky C, in E. long. 26°.

The apparently perfectly level interior of Lubiniezky includes, according to Neison, an ill-defined dull light spot on its dusky superficies. This feature lies on the western side of the floor. Mr. Sadler, observing the floor, 1872, October 12, noticed that a faint white, rather diffused streak was visible upon it, extending in a south-east to north-west direction. It reminded him of "the white streak on the floor of Plato, and seemed at times actually to be elevated above the floor of Lubiniezky." He observed it again in 1874, and, for the third time, on February 6, 1879, while using a fine unsilvered 10-in. mirror by Calver (*Selenographical Journal*, vol. ii. p. 21). No detail whatever is shown either by Neison or Beer and Mädler, and the only feature drawn by Schmidt is an inconspicuous curved ridge-like marking running closely parallel to the foot of the western border. On the evening of May 6, 1884, $9^h$ $30^m$, I searched for Mr. Sadler's marking with a power of 340 on a 8½-in. Calver, and was able to trace, with tolerable ease, a very faint broad light streak with ill-defined edges, extending over the floor from the northern wall and, gradually increasing in width, bending round towards the south-western wall. Forty-eight hours previously, when the formation was not far removed from the morning terminator, no trace of this phenomenon was observed. There can be little doubt that this streak was the same as that recorded by Mr. Sadler, and that it is of a similar character to those seen within Capuanus and elsewhere.

The bright mountain enclosure *a* on the north-east of Lubiniezky is undoubtedly the most remarkable object in the vicinity. Observed when the east wall of the former is on the morning terminator, its interior is filled with black shadow, while the innumerable craters on its southern flanks and the narrow valleys which traverse its border on the north are seen to great perfection with high powers under good conditions. At a later stage of sunrise a good view is obtained of one of the most interesting and suggestive winding valleys on the visible surface. This object originates on the west side of the interior of *a*, and, after exhibiting a number of tortuous windings in its course towards the south, terminates at a mountain-mass (which it cuts through) a few miles east of Lubiniezky. Schmidt alone shows any traces of it (Mädler only draws the mountain mass). According to him the valley is really a crater-row, but though often observed under good definition with high powers when numberless small craters were visible in the neighbourhood, I have not been able to confirm this. An excellent drawing by Lieut. Molesworth, R.E., under date 1891, Sept. 13, also tends to show that this curious formation is a true valley and not a zigzag crater-row. It may also be followed, but not very distinctly, in M. Prinz's twenty-four times enlarged photograph of Bullialdus and its environs.

T. Gwyn Elger.

Beaumont House, Shakespeare Road,
Bedford, 1895, Oct. 19.

# CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

## *On the Number of Figures necessary in Reductions.*

GENTLEMEN,—

In the notes "From an Oxford Note-Book" in the bservatory' for October, an opinion is expressed that much our is wasted in astronomical reductions. It may be so. But illustration by which this argument is enforced is certainly an ortunate one. This illustration is taken from an example of computation of a star-correction in R.A. given in the Intro- tion to the Radcliffe Catalogue (1890). The point insisted n is that the logarithms from the R.A. and N.P.D. Tables are ered *to five decimal places*, whilst decimals in the fifth place are nediately neglected by combining the sums with Day Constants ich are only given to four places of decimals, and that absolute uracy in the fourth place is useless, since no allowances are le for the difference of the Day Numbers between the Oxford d Greenwich midnight and for the time of the meridian passage the star and midnight. The logarithms from the R.A. and P.D. Tables are taken out directly from the Tables to the fifth ce of decimals, not to secure absolute accuracy in the fourth ce (although this is certainly no loss), but because it is found take less time to enter the extra figures than to contract them ore entry; and for the same reason, to save time and to avoid stakes, the Tables have been extended sufficiently to allow the uired logarithms to be directly copied out without any inter- ations whatever, whilst accuracy to the second place of decimals secured in the star corrections.

It may be asked—If the fifth places of decimals are not abso- ely necessary to secure accuracy in the star corrections, why e the Tables been extended to the fifth place?

The answer is that these Tables are also extensively used for computation of the precessions where the fifth places *are* uired to secure the necessary accuracy.

No allowance is made for the difference between the Day mbers at Oxford and Greenwich midnight, because these dif- ences only affect the star corrections in the *fourth* place of imals; and no allowance is usually made for the differences ween the Day Constants at midnight and the time of transit, ause the stars are usually observed within much less than six urs from midnight, and the star corrections are the same in h cases to the second place of decimals, except for stars near e pole, which are specially treated; but whenever the stars are served in the daytime, and the star corrections are different for e midnight and time of passage in the second place of decimals, e necessary corrections to secure accuracy are applied.

In fact, the reductions have been arranged *to save time and bour* in the computations whilst securing accuracy to the second ace of decimals in R.A.

In the computations of large batches of reductions much more is gained by saving the computer from the mental strain required in interpolations than is lost by the copying of a few extra figures.

The tendency during the last sixty years has been to insist upon greater accuracy in the reductions; and I do not believe that astronomers generally will be prepared to pass over errors of $0^s\cdot03$ or $0^s\cdot04$ in R.A.—which amount to about half a second of arc for equatorial stars—as of no practical importance.

Yours faithfully,
E. J. Stone,
*Radcliffe Observer.*

[Admitting fully the weight of the considerations advanced by an astronomer of Mr. Stone's great experience, I cannot yet change the opinion expressed in the note to which he refers, either on the general question of the waste of numerical labour or on the particular illustration which Mr. Stone considers unfortunate. For the sake of clearness I repeat this illustration here. Firstly, as given in the Radcliffe Catologue:

1890 Feb. 18. 68 Geminorum: R.A. $7^h\ 27^m\ 25^s$, N.P.D. 73° 56′.

| | *a.* | *b.* | *c.* | *d.* | *Sc.* |
|---|---|---|---|---|---|
| R.A. Table ......... | 9·57122 | 9·96755 | 9·96755 | 9·57122 | |
| N.P.D. Table ...... | −8·84121 | +8·84121 | +9·58551 | −8·28331 | +0·4875 |
| Day Numbers...... | −1·2122 | +1·0050 | −9·2670 | −9·5786 | −9·2670 |
| | +9·6246 | +9·8138 | −8·8201 | +7·4331 | −9·7545 |
| | +0·421 | +0·651 | −0·066 | +0·003 | −0·568 |

$$\text{Corr.} = \left\{ \begin{matrix} +1\cdot075 \\ -0\cdot634 \end{matrix} \right\} = +0^s\cdot44.$$

Secondly, let us repeat the calculation, using three figure logarithms throughout:

| | | | | | |
|---|---|---|---|---|---|
| R.A. Table ......... | 9·571 | 9·968 | 9·968 | 9·571 | |
| N.P.D. Table ...... | −8·841 | +8·841 | +9·586 | −8·283 | +0·488 |
| Day Numbers...... | −1·212 | +1·005 | −9·267 | −9·579 | −9·267 |
| | +9·624 | +9·814 | −8·821 | +7·433 | −9·755 |
| | +0·421 | +0·652 | −0·066 | +0·003 | −0·569 |

$$\text{Corr.} = \left\{ \begin{matrix} +1\cdot076 \\ -0\cdot635 \end{matrix} \right\} = +0^s\cdot44.$$

The correspondence of the final results is indeed much closer than appears, extending to the third place: viz. each is $+0^s\cdot441$. Indeed, if the computation be again repeated with *two-figure* logarithms, no sensible error is made. The last three lines read as follows:—

| | | | | |
|---|---|---|---|---|
| +9·62 | +9·82 | −8·83 | +7·43 | −9·76 |
| +0·417 | +0·661 | −0·068 | +0·003 | −0·575 |

$$\text{Corr.} = \left\{ \begin{matrix} +1\cdot081 \\ -0\cdot643 \end{matrix} \right\} = +0^s\,438.$$

Now if the great saving in figures and addition represented by using 3-figure logs. (or possibly 2-figure) instead of 5-figure can be carried systematically through the wholesale work of computing star corrections, surely it is worth doing, even if the 5-figure tables have to be written out again as 3-figure tables for the purpose. This re-writing of the tables is a capital expenditure, which would, however, be quickly repaid. I am not quite sure whether 3-figure logs. will be sufficient in all cases; if not, I have certainly hit upon an unfortunate illustration. With Mr. Stone's permission I should like to recur to the matter next month after examining the point a little more at leisure than is possible at the moment. The matter is of considerable importance, and the objections raised by Mr. Stone require full examination. At the same time, if they can be satisfactorily met, and if it can be shown that some of the great labour expended in computing can be saved, a result of some value will have been attained.—H. H. T.]

### *A new Method of determining Velocity in the Line of Sight.*

[Translation.]

Gentlemen,—

Having recently read the August number of your magazine, I hasten in the first place to express my sincere thanks for the translation of my article in the 'Astronomische Nachrichten,' No. 3289. In the second place, I venture to make some observations on your remarks accompanying this translation.

First, as to the "instrumental and observational errors," it seems to me that the only source of error to be feared is the changing of the indices of refraction of the prism, which perhaps might be produced by variations of temperature. As to actual instrumental errors, such as the flexure of the tube, for example, they are eliminated in great part, thanks to this, that the velocity sought is deduced from the variation of the length of the spectrum between two particular rays and not from isolated displacements. Secondly, as to the positions of the comparison stars "which might be in different parts of the sky," I ought to say that if the method is practicable (and I regret that I am not able myself to apply it, not having the necessary means at my disposal), one could measure the radial velocity of stars much fainter than of the second magnitude, and therefore one could always choose stars quite close together.

Thirdly, as to the small number of rays available for measurement in stars of Type I., I would remark that the same objection holds good to the measures of Prof. Vogel. But experience has shown that although these determinations are inferior to the determinations of the velocity of stars of Type II., this difference is not great. To this I would add that with a prism before the object-glass one would have many more lines than upon the plates obtained by the spectrograph of Prof. Vogel; for example, the photographs of the spectrum of α Lyræ made by Prof. Pickering show a quantity of lines which are not seen on the last-mentioned spectrograms.

Besides this there will be this advantage in the new method, that instead of the hydrogen lines, which are always diffused and large in Type I., one could use the lines of other rays, for example, those due to magnesium, which are very clear and fine in the majority of stars.

It is probable that the new object-glasses of Mr. Dennis Taylor will be of the greatest value for investigations of this kind, as they give a very long spectrum.

Yours very truly,
Artémie Orbinsky.

Astronomical Observatory,
Odessa, 1895, Sept. 26.

Gentlemen,—

Allow me to call attention to a slight oversight that occurred in the editorial introduction to the abridged article of M. Orbinsky on a "New Method of Determining the Velocity of Stars in the Line of Sight," on page 303 (August number) of this journal.

The statement is made that the method is "based on the fact of the irrationality of dispersion of a prismatic spectrum." It will readily be seen, however, that this is not the case, and that the method would apply equally well if, instead of an objective-prism, an "objective-grating" were employed; that is, if a large transmission-grating were placed in front of the object-glass of the telescope. It may be mentioned in passing that experiments have been made with objective-gratings by various observers, but in general the light of the stars is insufficient to permit the employment of sufficiently high dispersion. For the purpose of sifting out high velocities in the sight-line, however, it is possible that such plates might be of some service.

A plan for making objective-prism plates available for velocity determinations, identical in principle with that now proposed by M. Orbinsky, occurred to me some time ago; and in a letter sent to Professor Pickering in 1893, I suggested that the differential displacements of all sufficiently bright stars on a plate be obtained by reference to the spectrum of one star on the plate whose velocity was known. This would simply require that the perpendicular distance between the F lines in the two spectra (taken pair-wise) be compared with the perpendicular distance between (say) the K lines. In the computation the irrationality of dispersion must be taken into account, but the method cannot be said to be based upon it. A preliminary computation, for two stars whose sight-line velocity is known, has shown that the displacements, though small, are measurable quantities.

Dartmouth College, Hanover, N.H.
1895, Sept. 23.

Truly yours,
Edwin B. Frost.

[Prof. Frost is quite correct. The principle of the method nder discussion depends on the fact that a given motion in the ine of sight is represented by a different amount of linear dislacement for different lines in the spectrum. In the case of an bjective grating, there would of course be no irrationality of disersion. But if a grating should ever be used for this research, an bjective prism would have the advantage, as the difference of isplacement to be measured would be larger than with the grating. nd this difference would practically depend on the irrationality of ispersion of the prism. The sentence as it appeared was therefore ot strictly accurate, but we hope was not sufficiently erroneous to islead.—Eds.]

## *Discovery of Small Planets: small Perihelion Distances of a few.*

Gentlemen,—

On the last occasion before that which has just taken place at the meeting of the British Association was held at Ipswich, was presided over by the Astronomer Royal, afterwards Sir eorge Airy, in 1851. A passage in his opening address cannot t raise a smile amongst astronomers in these days when we are accustomed to the announcement of the discovery of small anets that a new one excites but languid interest. "The disvery," he remarked, "for which the year will be most frequently ted is that of three additional planets, included in the same anetary space—between Mars and Jupiter—in which eleven hers had been previously found. The last of these (Irene), disvered by Mr. Hind, observer in the private observatory of r. Bishop, forms the fourth of his list, and makes his number the eatest that any one man has ever discovered." This was written July 1851, and by "the year" is evidently meant the year ich had elapsed since the preceding meeting of the Association d been held. For the eleventh, Parthenope, was found in May 50, and Irene, the fourteenth, in May 1851. Before July of at year was out, De Gasparis equalled Mr. Hind's number of scoveries by detecting Eunomia, No. 15. Four was then the eatest number of planets which any one man had discovered; t Dr. Palisa's have since reached 82, and those of M. Charlois ade by the photographic method) have nearly equalled this, his t being apparently 78 in number, so that these two observers ve scored 160 new planets between them. And as to a year ing noted for the discovery of *three*, several recent years have tnessed the addition of more than twenty!

Mr. Ledger was, I believe, the first to point out some years o that Æthra, No. 132, which was discovered in 1873, comes en in perihelion within the orbit of Mars. He has recently lled my attention (by letter) to the fact that two of the more cently discovered planets do the same, and come a little nearer e Sun than Æthra. For the perihelion distance of the latter about 1·661; those of Brucia No. 323 and of No. 391 are about

1·564 and 1·562 respectively. These numbers exceed indeed the mean distance of Mars, which is 1·524, but they are smaller than his aphelion distance from the Sun, which amounts to 1·666.

Yours faithfully,

Blackheath, 1895, Sept. 20. W. T. LYNN.

### *Daylight Occultation of B.A.C.* 6127.

GENTLEMEN,—

Among the predicted occultations for August, kindly sent to me by Mr. Joseph Brooks, F.R.A.S., of the local Trigonometrical Survey, was one of B.A.C. 6127, a star of the fifth magnitude, for the 29th. The predicted mean times for the phases were $4^{\rm h}\ 15^{\rm m}\ 9^{\rm s}$ and $5^{\rm h}\ 26^{\rm m}\ 31^{\rm s}$. As both phases would occur in full sunlight, I had little hope of observing them with so small an aperture as 8 inches. Considering, however, that the Moon was in that part of the sky opposite to the Sun, I made the attempt. With a power of 138 diameters, the lowest belonging to the Cooke filar micrometer, I sought in vain for the star during the few minutes before the disappearance. I now substituted the square bar-micrometer, which has a much lower power, and at last succeeded in finding it. Its brightness was about equal to that of the faintest point on the Moon's illuminated surface, and I was obliged to keep my eye intently fixed on it in order to ensure an exact observation of the disappearance. This phase was well observed, and was instantaneous at $4^{\rm h}\ 15^{\rm m}\ 8^{\rm s}\cdot6$, local mean time. The square bar-micrometer is furnished with diagonal threads. One of these had been so adjusted as to be parallel to the star's diurnal path, and the disappearance itself was noted close to this thread. Keeping the telescope clamped in declination the thread served to point out the place on the Moon's bright limb where the star would emerge, and I had the satisfaction of observing the reappearance at $5^{\rm h}\ 26^{\rm m}\ 21^{\rm s}\cdot7$ local mean time. In consequence of the declining altitude of the Sun and the increasing altitude of the Moon the star was more distinct at the reappearance. The Sun's upper limb was observed to disappear behind the visible horizon six minutes six seconds after the star's reappearance. As the observation of an occultation of a star of so low a magnitude as the 5th in full daylight is probably a rare one, I have thought it would be interesting to record my experience in your journal.

Yours faithfully,

Windsor, N. S. Wales, JOHN TEBBUTT.
1895, Sept. 7.

## OBSERVATORIES.

CAPE OBSERVATORY.—Dr. Gill's Report for the year 1894, which has just reached us, naturally begins with a reference to the munificent gift of Mr. Frank McClean. This telescope will have

hotographic object-glass of 24 inches aperture and 22½ feet
ıl length, and will be provided with an objective prism of the
e aperture having a refracting angle of 7½ degrees. Mounted
ıllel to this there will be a visual telescope of 18 inches aperture
22½ feet focal length. A spectroscope and an observatory of
t construction are also included in the gift. Sir H. Grubb is
ected to have the instrument completed before the end of
5.

r. Gill then proceeds to point out the insufficiency of the staff
says "the whole question of the Observatory establishment
ssary for the uninterrupted and systematic reduction and
ication of results, and the orderly conduct of its general
ness, requires careful consideration. I propose, in 1896, to
ct the attention of the Lords Commissioners of the Admiralty
particularly to the subject."

s regards the astronomical observations, we are glad to see
work with the Transit-Circle, which had been to some extent
ontinued in 1892 and 1893, has now been resumed with full
ur. and that 4818 transits were observed and 5063 observa-
s of declination made.

r. Finlay detected and observed Tempel's second periodic
t, and Gale's comet was observed on 15 nights. With the
h telescope 512 observations were made for aberration and
ge of latitude. The heliometer was not in use.

s regards the Astrographic work, Dr. Gill reports that "After
ting all plates of insufficient exposure, or which are otherwise
y, only 70 of the Catalogue plates, out of 1632 areas assigned
he Cape, remain to be done. Of the chart-plates 263 have
passed as satisfactory." A number of plates were also
sed "for determination of the distortion of the optical field
omparing the photographic results with the co-ordinates of the
s derived from the discussion of the heliometer and meridian
rvations which were made in the years 1889 and 1890," and
determine independently a series of corrections to the star-
es derived from the previous discussion."

he publications passed through the press during the year are:

Cape General Catalogue for 1885, containing the mean
places of 1713 stars, derived from Observations made
between 1879-1885;

A Catalogue of 104 Southern Circumpolars;

The Annual Results, 1885-87, bound in one volume;

the work of printing the 'Southern Photographic Durch-
terung of 152,500 Stars' was commenced, as well as portions
e 'Researches on the Solar Parallax.'

e note that the Time Service is increasing.

---

ELBOURNE.—It is some time since we have had occasion to
mention of this observatory. In April 1893 we devoted
al pages to an article giving a history of the work of the

institution since its foundation, and in which we regretted the policy of retrenchment compelled by the financial state of the colony. Since then we have seen no publications from the observatory until recently, when we received two Reports of the Board of Visitors combined, covering Mr. Ellery's reports from 1892 September to 1895 May 30.

Several changes in the staff tending to diminish its strength are mentioned in these reports. In the first place, on 1895 June 30, Mr. Ellery resigned the office of Government Astronomer, which he has held since the observatory was established in July 1853, and has been succeeded by Mr. Pietro Baracchi. Mr. Baracchi has held the post of Chief Assistant since September 1892, when Mr. White, who formerly filled the office, retired on pension, as did another senior assistant, Mr. Moerlin. The vacancies thus caused have not been filled up, and other retirements have taken place, in accordance with the scheme of retrenchment. The Visitors naturally express their appreciation of Mr. Ellery's long and efficient service, and have arranged that he shall not at once leave the Astronomer's quarters, so that the new Director will still have the benefit of his advice and help.

The details of the work done, given by Mr. Ellery, do not show great signs of the straitened circumstances of the observatory. The total number of meridian observations made during the thirty-three months covered by the report were in R.A. 8633, in N.P.D. 4685, which compare favourably with the average of previous years. The Great Telescope was used in 1893 for examination of the nebula in Argo, the object on which it has been so often turned during its career, and in 1894 physical observations of Mars were made with this instrument. This telescope used to be put at the service of visitors to the observatory on several nights in each month; but of late this arrangement has had to be curtailed, owing probably to the reduction of the staff.

The photographic services have been continued with only slight diminution. Sun-pictures were taken whenever weather permitted during the years ending September 1893 and 1894, the numbers being respectively 141 and 134. Since the latter date, for pecuniary reasons, it has been the practice to take photographs only when there were signs of solar disturbance. The number taken under this arrangement is 70. For the work of the Astrographic Chart, to which it may be remembered Melbourne is contributing the Zone 65° to 90° S. declination (1149 plates), 898 plates have been taken for the catalogue series and 40 for the chart series. A micrometer has been obtained for measuring these, but little has been done in this direction beyond experiments.

The testing of chronometers and other instruments and the system of time distribution have been carried on as before, except for the change necessitated by the adoption of the zone-time system on February 1 last, which makes Melbourne time 10 hours fast on Greenwich instead of $9^h\ 39^m\ 54^s$. The magnetic and ieteorological observations have been made as usual, but the rinting of the results and reports has had to be condensed, hich Mr. Ellery thinks an improvement, but he apparently does ot acquiesce in this economy of printing when applied to astro-omical results. He says:—"As regards publication of our stronomical work nothing has been done since vol. vii. was pubshed in 1888, as for reasons of economy it was desirable to limit ur demands on the Government Printer as much as possible. t has been our custom to publish an annual volume of our meriional observations with an annual catalogue deduced therefrom, nd in 1870 and 1880 a ten-year star catalogue was issued. The nnual Catalogues for the years 1884 to 1893 are ready for the rinter and that for 1894 is nearly complete; but under existing ircumstances I think it will be the best course not to continue he yearly volumes and catalogue, but to combine the whole into ne general catalogue, in which case it would probably be best to elay a little longer and bring it up to the epoch 1900." To which atalogue we, doubtless in common with the astronomical world, ook forward with expectant interest.

---

## PUBLICATIONS.

Mr. Stanley on the Nebular Theory[*].—This work does ot lend itself easily to the reviewer. By the nature of the case, t consists to a large extent of speculations and suggestions. But hen these are offered as the results of long-continued thought y a writer imbued with the scientific spirit, they invite our arnest attention, and unquestionably all future discussions of the ubject must take account of the views and reasonings here placed efore us. The introductory chapter naturally contains an hisorical sketch giving a survey of the views of Wright, Kant, Descartes, Herschel, Laplace, Helmholtz, Faye, and others. The uthor passes on to consider the conditions of matter possibly ctive in the condensation of an extensive system of cosmic ebulæ—for, in speculations of this kind, our solar nebula cannot e considered independently, but as part of a general system of ebulæ. Quoting a suggestion of Sir Benjamin Brodie with egard to a former wider division of matter than that of the tomic state, Mr. Stanley says:—

"I propose the word *pneuma* to specially define this most ttenuated form of gaseous matter which may have pervaded pace, composed of any or all the chemical elements, and which represented the state of infinite diffusion proposed by Helmholtz. This matter would be transparent and not be visible in any form except when undergoing chemical combination or in condensation to form the visible nebula. The pneuma, in condensing to form the nebula, may be assumed to develop heat and electrical excitation, which renders the nebula condensed therefrom incandescent at the time." Justifying himself for introducing a new term rather than adopt that of the "primitive fluid" of Lord Kelvin or the "protyle" of Mr. Crookes, the author goes on to state that "the idea herein intended to be expressed by pneuma is that it is an active substance composed of units which represent, separately or in combination, all the various properties of matter. These separate distinct elements, of which there are assumed to be a much greater number than that of our acknowledged chemical elements, may amount possibly to 10,000 or more factors or varieties. Upon this proposition it is more probable that chemical elements may be split up into many more elements, than that they may hereafter be reduced in number by finding any more generally specialized constituent material or atom."

---

[*] 'Notes on the Nebular Theory in relation to Stellar, Solar, Planetary, Cometary, and Geological Phenomena.' By William Ford Stanley, F.R.A.S., F.G.S., &c. (Kegan Paul, Trench, Trübner, and Co.)

The next chapter deals with the formation of nebulæ from the original pneuma system; and the fourth passes on to the condensation to a solar centre and the formation of planetary and cometary orbits. A discussion follows of the mechanical principles upon which our solar-planetary system may have been formed, adopting the theory proposed by Laplace, but suggesting some modifications in detail. From the known distribution of bodies in the solar system, certain deductions are inferred with regard to the probable form of the original planetary nebula; and suggestions are offered to account for the direction of rotation of the Sun and planets. The revolutions of the satellites and comets are considered in the eighth and ninth chapters; after which the book is chiefly concerned with the formation of the Earth itself, considered as a model or specimen planet.

We have not space to enter at any length into this concluding portion, which is necessarily more related to geological than to astronomical science; but it will be found replete with interest, and the author's suggestions are at any rate deserving of careful study, particularly with regard to glacial and other periods. In the sixteenth, the final chapter, he treats of geological periods correlated with astronomical phenomena; and it is consoling to find that he thinks it probable that the world-life upon our Earth will be longer than the 15 millions of years suggested by the theory of Helmholtz for the Sun to decrease in volume till it becomes of the density of the Earth.

As we remarked at first, it is difficult to give a clear idea of a work of this kind in the compass of a short review; but we can confidently assure our readers that their time will not be wasted in endeavouring to obtain one for themselves by actual and repeated perusal.

The author in his preface acknowledges his obligations to Mr. Crookes, F.R.S., and Prof. Fitzgerald, F.R.S., for suggestions and to Mr. W. T. Lynn for help in preparing the book, which is considerable guarantee of the accuracy of the work.

---

It might be thought that sufficient had already been written about the family of Herschel. In her latest work[*], however, Miss Agnes Clerke has shown that the subject is not yet exhausted, but re-tells the well-known story and anecdotes, with a freshness of treatment giving to them the charm of novelty, and has added much which is not so well known, thus making a book remarkable both for its literary style and for its instructiveness.

It is Sir William Herschel who naturally occupies the greater part of the book. Miss Clerke shows us the intimate life of the great astronomer as the musician at Bath, where astronomy was only an arduously followed relaxation from professional duties; at the dilapidated house at Datchet, where his primary duty was to gratify the royal taste for astronomy, but where he supplemented the small income received from the King by the proceeds of an optician's business of considerable extent[†]; and later at Slough, where he was able to follow his chosen science under circumstances more easy and more dignified, receiving visitors drawn from the highest social and scientific circles.

An advantage that this biography has over some is that the work of the person whose life is being set down is written by a specialist on the subject. In writing of the work of Sir William Herschel, Miss Clerke has given a history of the state of astronomy at the close of the eighteenth century and the beginning of this, which may be taken as a fit prologue to her well-known book. Moreover, she points out in an instructive chapter the influence of Herschel's work on modern astronomy. That it is to William Herschel that we are indebted for the filar micrometer; that his large telescope was the prototype of the 5-foot reflector and giant refractors of to-day; that his suggestion of a group of stars clustering in space about our Sun has been verified to some extent by Dr. Gould and others; and that the Astrographic Chart now being made may supply a gauge of the skies by magnitudes, by which may be studied the "construction of the heavens" on the plan initiated by Herschel.

In her preface to the book Miss Clerke modestly says: "Sir John Herschel's life has yet to be written." We feel inclined to say that we scarcely see in what respect the biography now before us falls short. The life of the younger Herschel was that of a man of first-class attainments and of circumstances which permitted him to devote himself entirely to science; and possibly Miss Clerke means that the work of such a man could not be contained in a book of this size. It may be so; but we do not hesitate to say that the chapters on Sir John Herschel give as perfect an account as could be wished for in a book for general reading such as this.

---

[*] 'The Herschels and Modern Astronomy,' by Miss A. M. Clerke. The Century Science Series. (Cassell and Co., London.) 1895.

[†] It may not be generally realized how extensive this business was. We are told that he received £3150 for one telescope, £2310 for two smaller ones, and the commissions that he executed were innumerable.

To the other character of the book—Miss Caroline Herschel—one chapter only is assigned; but her personality pervades the accounts of the lives of both her brother and nephew. Miss Clerke's apt description of her as the "Cinderella sister" seems suitable; but would not the character of the "good fairy" be more appropriate to the lady who not only set in fair order the multitudinous observations of her talented brother, but also obtained a baronetcy for her nephew? If this book has done nothing else it certainly has shown in a lovable light the character of Miss Caroline Herschel.

We trust that this sketch, though brief, is sufficient to make it clear that the book is one to be bought and read.

---

A LUNAR ATLAS*.—We have lately received a handy series of twenty-five charts showing selected regions of the Moon's surface made by Herr Phil. Fauth, of Kaiserslautern. The author has used photography in the construction of these charts to make as it were the ground-plans, but has filled in the details from eye-observations at the telescope, which appears to be an excellent method, as it is not open to the objection, sometimes urged against lunar photography, that the plate itself is responsible for the appearance of some lunar details which are not seen by the eye. The atlas is accompanied by text descriptive of the regions charted, and the book, which is in fact the result of Herr Fauth's work for the years 1893 and 1894, also contains some miscellaneous researches by him on lunar matters, on Jupiter in 1893, and an investigation of the limits of magnitude of stars as seen by telescopes of different aperture.

---

DOUBLE-STAR MEASURES.—We have received two sets of double-star measures from observers whose early publication of their work it is a pleasure to note. So recently as 1894 June we had occasion to compliment Prof. Glasenapp on his measures of southern doubles made during his summer holiday of 1893. It appears that on his return from Abastouman he set about constructing a small observatory at Domkino, in the Government of St. Petersburg, for the 9½ refractor, and managed before returning to his University duties to make over 200 measures.

His summer vacation of 1894 was spent at Domkino, and during the period June 30–Sept. 23 he secured about 650 additional measures. These observations, together with some made at St. Petersburg 1882–89 with a 4-inch, and some made at Domkino n 1889 with a 6½-inch—altogether about 600 stars—Prof. Glasenapp has now published as his 3rd series of double-star measures *, and we gather that while this work was passing through the press he was also busy spending his 1895 summer vacation in compiling a 4th series.

---

* Neue Beiträge zur Begründung einer Modernen Selenographie und Selenologie, gesammelt auf seiner Privatsternwarte zu Kaiserslautern, von Phil. Fauth. Leipzig, 1895.

The second set † is from Mr. W. Maw, who, after a busy professional day, returns to Kensington and his 6-inch refractor, and finds his needful recreation in measuring stars badly wanted and near the limit of his telescope.

Mr. Maw's contribution of 100 stars includes 50 between 0″·6 and 2″·0 and 16 between 2″·0 and 3″·0.

## NOTES.

Comet Notes.—Ast. Nach. 3312 contains a further investigation of the orbit of Holmes' Comet (1892 III.) by H. J. Zwiers. The following are the elements for the next return after applying perturbations by Jupiter and Saturn :—

Epoch 1899 Jan. $12^{\mathrm{d}}{\cdot}0$ G.M.T.

| | | |
|---|---|---|
| M .... | 1241274″·4 | |
| π ...... | 345° 47′ 51″ | 1899·0. |
| ☊ ...... | 331 43 38 | |
| i ...... | 20 48 15 | |
| φ ...... | 24 17 2 | |
| μ ...... | 516″·4121 | |
| log q .... | 0·55801 | |
| Perihelion Passage | 1899 April $27^{\mathrm{d}}{\cdot}97$ | |

An ephemeris is given from 1898 Feb. 16 to 1898 Sept. 14. Throughout this period its declination is 40° or more south.

The following elements of Swift's Comet (1895 II.) are by Dr. Berberich and Prof. Boss respectively :—

| T=1895 Aug. $20^{\mathrm{d}}{\cdot}8848$ Berlin M.T. | | | Epoch 1895 Aug. $24^{\mathrm{d}}{\cdot}5$ G.M.T. | | |
|---|---|---|---|---|---|
| | | | M .... | 0° 30′ 41″ | |
| ω ...... | 167° 47′ 8″ | | ω .... | 167 42 19 | |
| ☊ ...... | 170 16 17 | 1895·0. | ☊ .... | 170 18 7 | 1895·0. |
| i ...... | 2 59 25 | | i .... | 3 0 11 | |
| φ ...... | 40 22 18 | | φ .... | 40 44 17 | |
| μ ...... | 502″·654 | | μ .... | 491″·590 | |
| log a .... | 0·56583 | | log a .. | 0·57227 | |
| Period .. | $7^{\mathrm{y}}{\cdot}06$ | | Period. | $7^{\mathrm{y}}{\cdot}22$ | |

---

* 'Mesures Micrométriques d'étoiles doubles faites à St. Pétersbourg et à Domkino, par le Prof. S. de Glasenapp.' St. Petersburg, 1895.

† 'Double Star Observations, 1862–94,' by W. H. Maw. Reprinted from Memoirs R.A.S. vol. li. London, 1895.

The following is a rough ephemeris:—

| | R.A. | | | N. Decl. | | | R.A. | | | N. Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | h | m | s | ° | ′ | | h | m | s | ° | |
| Nov. 1 .... | 1 | 28 | 37 | 3 | 28 | Nov. 9.... | 1 | 30 | 33 | 3 | 4[illegible] |
| 5 .... | | 29 | 31 | 3 | 34 | 13.... | | 32 | 39 | 3 | [illegible] |

We continue Engström's ephemeris for Faye's Comet:—

| | R.A. | | | S. Decl. | | | R.A. | | | S. De | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | h | m | s | ° | ′ | | h | m | s | ° | |
| Nov. 2.... | 21 | 22 | 32 | 5 | 31 | Nov. 22.... | 21 | 46 | 30 | 5 | [illegible] |
| 6.... | | 26 | 30 | 5 | 42 | 26.... | | 52 | 24 | 5 | [illegible] |
| 10.... | | 30 | 52 | 5 | 49 | 30.... | | 58 | 36 | 5 | [illegible] |
| 14.... | | 35 | 39 | 5 | 54 | Dec. 4.... | 22 | 5 | 6 | 5 | [illegible] |
| 18.... | | 40 | 54 | 5 | 56 | 8.... | | 12 | 0 | 5 | [illegible] |

The brightness is now very slowly declining. A. C. D. C.

---

Minor Planet Notes.—The unappropriated number 330 has been assigned to 1892 X, discovered by Wolf 1892 March 18.

Planets BW, BX, BY, discovered by Charlois on 1895 March 21, May 18, and June 20, have been numbered 402, 403, 404 respectively. The suspected identity of BX with 156 Xanthippe has been disproved.

Two new planets—CC, CD—were discovered by Wolf on Oct. 13 and 19 respectively. A. C. D. C.

---

The Constitution of Saturn's Rings.—Prof. J. E. Keeler's spectrographic observations of the rings of Saturn, which have been described as an optical demonstration of the fact that the ring-system is composed of a multitude of disconnected particles, will be fresh in the memory of our readers. A letter from Prof. Keeler on the subject appeared in the 'Monthly Notices' of June last, and another in this magazine for the same month. Since then the conclusion drawn from these observations has been called in question by some authorities—Prof. Seeliger, in Ast. Nach., No. 3295, and M. Deslandres, in 'Comptes Rendus,' Vol. cxx. p. 1155,—not in such a way, however, as to cast any doubt on the observations themselves, but merely on the reasoning which showed these to be a proof of the meteoric constitution of the ring: for, say the objectors, the appearance of the spectral lines as seen by Prof. Keeler does not imply any separation of the ring in a tangential direction—that is to say, the same appearance would be produced if the ring were made up of many concentric rings,—nor does it imply separation in a normal direction beyond a certain point.

Prof. Keeler replies to these objections (Ast. Nach., 3313) as follows, remarking at the same time that he does not wish to claim for his observations more significance than they deserve, but that the interest lies in their independence of previous investigations of this matter:—

"The observations show that within certain limits the velocity at any point on the ring is that of a free particle moving in obedience to Kepler's third law. Hence the ring is not a solid sheet, nor is it made up of two solid sheets separated by the Cassini division, and thus the explanation of the ring naturally suggested by its telescopic appearance is shown at once to be untenable. This conclusion I have considered to be the significant result of the spectroscopic observations, for while it has been rendered more or less probable by various observed phenomena, it has been proved only by mathematical investigation of the stability of the ring. Now between the above-mentioned explanation and that which assumes the complete division of the ring into separate particles there is none that can be accepted without distrust. The hypotheses of rigid and of meteoric structure are both natural and perhaps about equally probable without the application of special tests, but compared with these two the intermediate hypotheses that have been advanced are artificial or inherently improbable. I have therefore regarded the disproof of the rigid structure of the ring, afforded by these observations, as practically equivalent to a proof of its meteoric constitution."

Prof. Keeler claims that his observations have equal right to be considered a "proof" with Prof. Seeliger's photometric observations. Prof. Seeliger pointed out in 1888 that the unvarying brilliance of the outer rings under all angles of illumination from 0° to 30° can be explained on no other hypothesis than that which assumes the rings to be formed of discrete satellites.

---

$\alpha$ CENTAURI.—Mr. A. W. Roberts has investigated the mass, proper motion, and position of this system from all available meridian observations at the Cape. Beginning with the measures of Henderson in 1832 and 1833, and ending with those of Dr. Gill in 1879–81, he divides them into nine groups, and from the nine equations thus obtained, in combination with the orbital elements as deduced by himself quite recently, he finds (1) Position of the centre of gravity of the system for 1880:

$$\delta = -60^\circ\ 20'\ 20''\cdot64 \pm 0''\cdot13,$$
$$\alpha = 14^h\ 31^m\ 27^s\cdot537\,;$$

(2) Proper Motion in R.A. $-7''\cdot291$ and in N. P. D. $+0''\cdot750$;
(3) Relative masses $\alpha_2 : \alpha_1 = 51 : 49$.

These values are almost identical with those obtained by Dr. Elkin.

Mr. Roberts remarks that "the new Cape spectroscope will within a few years yield sufficient material for another determination of the relative masses of $\alpha_2$ and $\alpha_1$ Centauri, but unless the measures are accurate to one or two tenths of a mile, the new determination will be very little better than the present."

The total mass of the system is sensibly equal to two of our Suns, so that $\alpha_2$ Centauri is very slightly heavier than our Sun, and $\alpha_1$ slightly lighter. But $\alpha_2$ is at present five or six times brighter than $\alpha_1$, and accordingly $\alpha_2$ must be intrinsically brighter than $\alpha_1$. Further $\alpha_2$ is as bright as our Sun, while $\alpha_1$ is about five times fainter and is therefore some distance on the downward track from the dignity of a Sun to that of an ordinary planet.

In a further note he gives an ephemeris of the relative positions of $\alpha_1$ and $\alpha_2$ up to 1910. The comparison between Dr. See's orbit and that derived by Mr. Roberts shows the two to be practically the same. The period is 81·185 years and $a = 17{\cdot}71$.

Both papers are in the 'Astronomische Nachrichten,' 3313.

---

THE death is announced of E. von Rebeur-Paschwitz whose name will be remembered as associated with a somewhat little used instrument, the horizontal pendulum. Rebeur-Paschwitz was at first a student of astronomy, and made investigations with the above-named instrument which were at first of an astronomical character, but the sensitiveness of this instrument, the original form of which he improved, to earth-tremors led him to take up the study of seismology, in which he became a high authority. He communicated frequently to the 'Astronomische Nachrichten,' and wrote an admirable summary of his results for the British Association meeting of 1893. Rebeur-Paschwitz died a young man, only thirty-four years of age, but a biographer has said that "he had done work which most men of twice the age might regard with satisfaction as the fruits of a well-spent life."

---

DR. SEE has an important paper in the 'Astronomische Nachrichten,' No. 3314, on the "Theory of the determination, by means of a single spectroscopic observation, of the absolute dimensions, masses, and parallaxes of stellar systems whose orbits are known from micrometrical measurements, with a rigorous method for testing the universality of the law of gravitation."

Recognizing "that the apparent orbit of a double star furnishes no criterion as to the law of central force, and that a demonstration of the Newtonian law for the stellar systems is impossible," he was led "to consider the application of the spectroscope to confirm the node and inclination which result from the theory of gravity."

At the outset he pays a tribute to Mr. F. R. Moulton, of Chicago, for his proof "that the aberrational orbit of a fixed star is the hodograph of the ellipse in which the Earth moves, and therefore a circle." Dr. See then proceeds to prove this proposition and to show the application of the formulæ, and to give the results of calculation in the case of twelve well-known binaries.

In fact, Dr. See has calculated the fractional part of the velocity in the line of sight at the epoch 1896·50, and in two cases, viz. *a* Centauri and 70 Ophiuchi, where the parallax is well known, he has given the values in kilometres.

He remarks that "it will probably be necessary to choose stars which are bright and approximately equal in magnitude, and if some observatory could obtain the spectroscopic observations for ıs, the knowledge gained would be more valuable than all determinations of parallax put together." The deter- of parallax here proposed is independent of the distance the components, so long as the angular diameter of the ; not fall below $0''\cdot 2$, which, according to the double-star Burnham, is about the limit of measurement with our elescopes. The possibilities are therefore enormous.

ETASTE OF WINTER.—The low temperatures experienced e the 24th October have been very remarkable. The ıre has fallen below 30° on four days, the lowest recorded ing been 27°·4 on the 28th. Instances of temperatures ' are somewhat infrequent in the month of October. In ars 1841–1894 there have been four such cases recorded ɪyal Observatory in each of the years 1842, 1843, 1859, d 1887. The lowest recorded temperature in October ı has been 24°·7 on 1890, October 28.

s. WESLEY AND SON, of 28 Essex Street, Strand, have atalogue of books on astronomy, many from the libraries e Sir G. B. Airy and Mr. A. C. Ranyard. That this list omplete may be gathered from the fact that it includes ıs, all skilfully arranged in their proper sections. The the circular would form a good model for anyone about gue his astronomical library. We think this price-list perusal.

nnounced that the University of Pennsylvania is about to an observatory about five miles from Philadelphia. An ıatorial with a spectroscope is to form part of the equip- 'he institution is to be called the Flower Observatory, . Doolittle is spoken of as the first Director.

## FROM AN OXFORD NOTE-BOOK.

vertisement of a new novel entitled 'Mercia, the Astro- oyal,' caught my eye the other day, and I invested five I hope I may save others throwing away good money. is of "the Coming Woman and Coming Conventions," ingenuity in imagination which we have a right to expect author who asks us to think of the date 2002 (but 2 ?) is conspicuously absent. The events might have a few thousand years ago instead of a thousand years People carry daggers (electric) and fight duels (in flying ), and emperors are autocratic and profligate, in the most lace manner. The book is indeed utter trash. The ical allusions are very few and as worthless as the rest ook. I give one or two here, because there is a certain in following fragments of truth through their various phoses even to the grossest caricature. Mercia is Astro- oyal, women being in 2002 quite equal with men. She was "devoted to her profession; and so great was her enthusias m that for fully six months in each year she made her observatio ns of the heavens all night long, snatching only an hour or two in the daytime for sleep. She had discovered, with the aid of t he powerful instrument that Geometrus, her chief assistant ast o-nomer, had invented, the existence of a number of new plan ts which revolved round one of the principal suns, hitherto n-known." She and Geometrus were in love with each other; ut "it was a law, or, rather, a regulation, which was strictly enforc d, that no Astronomer to the Emperor might marry." Hence co n-plications; for the Emperor came to learn from Mercia " he cause of this change of temperature, not only in my dominio ns, but throughout the world. For three successive years an extre ne cold had prevailed each season." Mercia replies: "Some seri us internal changes are taking place within the body of our S n. Great caverns, about one-fourth of the Sun's diameter, have is-covered themselves in his centre. But it is only a tempor ry inconvenience; from close observation I find that our Sun is absorbing numerous meteoric bodies....... In this way he hydrogen of the fixed stars is pressed into our Sun's service an a constant heat sustained, which may last for thousands of year to come..... There is no cause for alarm." Thus reassured if indeed he had ever been alarmed, the perfidious Emperor, tho gh already a married man, proceeds to make love to Mercia, but so clumsily that for a time she thinks he is merely giving her p r-mission to wed Geometrus. When she realizes the situation, he calls him appropriate names and produces the electric dagg r; but extreme measures are averted by the entry of the Emper r's cousin, and the discovery of a Radical with a phonograph who as been behind a screen all the time, and afterwards makes his pho o-graph reproduce the scene in Court. This last move is necess ry because the Emperor has denied the whole affair, and had "a ter much cogitation evolved the feasible explanation" that he ad been merely requesting Mercia "to make calculations of e ch perturbation of the Sun's centre; and also to discover to w at extent the additions of meteoric matter to his body would aff ct solar heat." The substitution of the personal interview for offic ial correspondence in such a case, if we are to look forward to t is development in 1000 years or so, will still have some disadvanta es apparently. This may comfort us when burdened with he weight of blue-papers.

---

AMONG the Reports of the recent Ipswich Meeting of he British Association is one of great interest on the Earthquake a nd Volcanic Phenomena in Japan, chiefly the work of Prof. Jo hn Milne, F.R.S., the Secretary to the Committee. The report is ot as extensive as it might have been owing to a most unfortun te accident, which Prof. Milne thus describes in the Report:—"It is with regret that I have to announce that on February 17 y house and observatory were entirely destroyed by fire. The loss es consisted of collections of books, instruments, and other thin gs ulated during the last twenty years, the stock of the actions of the Seismological Society, which at the time were l ready for shipment to Europe, and about 1500 books and lets relating to Earthquake and Volcanic Phenomena. All saved was the clockwork of a new seismograph and a bundle tograms. The analysis of the latter forms the chief portion s report." The deepest sympathy will be felt by everybody Prof. Milne under these trying circumstances. We are ly reminded how necessary it is to have all observatories protected against fire. The destruction of the records of is no small matter.

---

ORTION of the above report which concerns astronomers very is that dealing with the action of dew. "A very large ity of dew is trapped *in* the ground, as it comes *upwards*," Prof. Milne to me in drawing attention to this part of the . "*It helps to tilt your instruments.*" Looking to the report, the action described in greater detail:—During a hot day ire is evaporated from the soil, and this is perceptibly heated epth of about one foot. Shortly after sunset the surface to h of one or two inches is chilled, or in winter it is frozen. result of this is, that moisture rising as vapour and by rity from water-bearing strata is condensed on the underside chilled surface. There is thus a redistribution of load on oil. Further details would be out of place here; but the question of the redistribution of load on the soil by rain ew, and the consequent tilting of the surface strata, is an tant one for astronomers. It suggests among other contions that the best place in this respect for an observatory at plain, where such actions would be nearly uniform; and hill, which may bend about under the varying action of es of the kind considered. An instance in point may be . The transit-circle at the Royal Observatory, Greenwich, s about 10″ or 12″ a year periodically, in both level and th. It is very possible that the situation on a hill has hing to do with this periodic swing, which surprised Airy uch when the instrument was set up. The University vatory at Oxford is in the middle of a flat park, and the neighbourhood is more or less flat; and the variations of and azimuth throughout the year are very small—2″ or 3″ The point seems at least worthy of consideration.

---

E following interesting letters from General Tennant, F.R.S., ly require any comment. It is not the Canal season just but the facts are fresh in the memory of most of us:—

day or two ago one of my spectacle-lenses fell out, and putting it in and adjusting the cylindrical surface (which is imes rather fatiguing), I found that a straight line, at only an inch from the point where it was in perfect focus, looked hree *black* lines separated by grey spaces; in fact, it would been difficult to devise any better representation of two parallel canals. Now, with those lenses, my vision is (I think) very good; for instance, I can see every grain in the half tints of the accompanying prints with ease in a fair light. Evidently, then, the usual accommodation of the eyes was affected by the strain they had been put to; and the result was to produce exactly the appearance described as seen on Mars. I believe it has before been suggested that some such cause produced the phenomenon; but, as far as I know, no one has actually seen the precise thing occur: I have, and perhaps you may think it worth recording.

"P.S.—I should perhaps say that I find the plane of the astigmatism of my eye changes, for both; and that, consequently, I cannot adjust by marks, but have to find the best positions of the lenses by trial when they fall out or weary me in use."

*Later.*—"It only occurred to me this morning that my illustration had a serious flaw, inasmuch as the phenomenon was produced with *both* eyes, used together, whereas the astronomical one is of course produced in only one. Probably, therefore, it is not likely to convince: but, in fact, the duplication of an image in a telescope is familiar to me of old—it is a common result of fatigue; in this case it was far more evident than I ever remember seeing it, and that was probably owing to both eyes being involved. As a matter of fact, a disc (such as that of the Moon) is never to me single, unless I have spectacles. Owing, I suppose, to the astigmatism, and the fact that the planes of symmetry in the eyes are not parallel, I always see overlapping images, unless I use suitable glasses."

---

THE mother of a bright little maiden recently told me the following story. Her daughter returned from school one day with a somewhat grave face, and announced that her faith in the teaching powers of her instructress had been rudely shaken. "She was explaining some astronomy to us, mother; but one thing she said was too hard for us to understand. Now if she had only read Sir Robert Ball's book she would have known that it could be made perfectly clear to *any* child."

---

THERE is a small matter to which I venture to beg the attention of American astronomers, after some experience of cases in which it has been overlooked, viz. the proper stamping of European letters. It is no uncommon thing at Oxford to pay 5*d*., 10*d*., or sometimes 15*d*., excess on letters received from America, because of insufficient stamping by *half* these amounts on the part of the sender. The contents of the letters are often well worth the money, though there are disappointing exceptions: but even the most valuable contributions would not lose in interest by the elimination of this extra fee on receipt of them. It is quite possible that we are equally negligent on occasion and that the balance is adjusted on the whole so as to favour nobody except the Post Office. But most of us would, I think, prefer to make a contribution to that excellent institution in some other way.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

No. 234. DECEMBER. 1895.

## MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, November 8, 1895.

Dr. A. A. Common, F.R.S., *President*, in the Chair.

*Secretaries*: Prof. H. H. Turner, M.A., B.Sc., and
E. W. Maunder.

*Mr. Maunder.* Since the date of the last Meeting 195 presents have been received by the Society. Of these might be specially mentioned a work by Mr. Leeson Prince, which is a literal translation of the Astronomy and Meteorology of Aratus, with notes thereon, presented by the translator; and also a book entitled 'The Herschels and Modern Astronomy,' by Miss Agnes Clerke; another, by Sir Robert Ball, on 'Great Astronomers'; and a third on the 'Nebular Theory,' by Mr. W. F. Stanley—all these presented by their respective authors. Mr. T. R. Clapham has sent us two lantern-slides showing views of Hammerfest and Vadsö, which are of interest in connection with the Solar Eclipse of next August. Dr. Sheldon has given to the Society a photograph of part of the Milky Way.

A vote of thanks was accorded to the donors of the presents.

*Prof. Turner.* Among the papers sent in are two on mathematical astronomy, which do not lend themselves well to reading at our Meeting. We have one by Prof. E. W. Brown on "Hansen's Lunar and Planetary Theories," and another by Mr. Cowell, an Isaac Newton Student at Cambridge, on the "Value of the Longitude in the Lunar Theory when the Sun's Mass is put zero." It was remarked by Mr. Stockwell that if, in Delaunay's Lunar Theory, the mass of the Sun were put equal to zero it might have been expected that elliptic motion of the Earth would result, but that on making the substitution there were certain inequalities which refused to vanish. Mr. Cowell points out a reason for this apparent anomaly, and proves his point by an appropriate mathematical investigation.

Besides these we have three papers by Prof. Barnard. One of them is an observational paper, giving determinations of the diameters of Ceres, Juno, and Vesta from observations made with the 36-in. equatorial at the Lick Observatory; and he gives the result of his measures in the form of a diagram, in which the planets are represented on the same scale as our Moon. The results of his measures are that, reduced to unit distance, the diameter of Ceres is 0″·389, Pallas 0″·244, Juno 0″·095, Vesta 0″·195. Turning these figures into English miles, they become — Ceres 485 miles, Pallas 304 miles, Juno 118 miles (but he says this was too small to be measured with accuracy), and Vesta 243 miles. Prof. Barnard says:—"These results, I believe, are very accurate, and I think we have now for the first time satisfactory information as to the dimensions of these *three* asteroids. I am convinced that the diameters of Ceres, Pallas, and Vesta are as well known as are those of the four bright moons of Jupiter. I hope to take up the measurement of these bodies with more powerful optical means in the near future, and, if possible, extend the list to other members of the asteroid group. In June 1896 Juno will be very well placed for observation." These measures represent laborious work at the telescope on the part of Prof. Barnard.

*Capt. Noble.* I should like to ask whether Prof. Barnard states the aperture with which he made the observations.

*Prof. Turner.* Yes; with the 36-in. equatorial.

*Capt. Noble.* But was the aperture stopped down?

*Prof. Turner.* He does not say.

*Mr. Dyson.* As I have tried on two or three nights lately to measure the diameter of Juno, but on most occasions could not make any difference between it and the stars around it, I should be glad if Prof. Turner would give a few more particulars about Prof. Barnard's measures.

*Prof. Turner.* The measures were made with a thousand diameters, except on one or two occasions, when 1500 was employed, but 1000 was found more satisfactory. He says—"I have also secured measures of Juno on four nights; the disc was extremely small, and was nearly the size of the spurious disc of a star of the same magnitude, so that it must be taken as showing only a possible maximum diameter. I feel confident, however, the disc was seen, and it seemed sensibly enlarged with higher powers. The actual measures were:—on 1895 July 21, observed diameter 0″·16; on July 22 0″·4; on August 5 0″·11. These, when reduced to unit distance, come to 0″·11, 0″·19, 0″·08. Prof. Barnard has given his result for Juno as only approximate, or, as he calls it, a maximum result. Prof. Barnard has also sent a short note on the invisibility of Hind's variable nebula. It will be remembered that in May last he sent us a paper on the variable nebulæ in

rus; and it appears that he has taken the first favourable
ortunity to examine the region again with the 36-inch, and
Hind's nebula, which he saw in 1890 and last winter, has
ppeared. "To my surprise, no trace of Hind's nebula could
een; T Tauri was seen on each occasion." Finally, there is
her paper by Prof. Barnard with reference to a paper
Roberts recently read at this Society, and which is more or
of a controversial nature. I think it will be best read by the
ows in print, especially as Dr. Roberts is not able to be here.
. Barnard criticises adversely Dr. Roberts's remarks on the
parison between photographs taken by a small telescope and
e taken by Dr. Roberts with a large reflector, and states
e points in which he differs from Dr. Roberts.
hotographs of the Nebulæ ♅ VI. 41, ♅ VIII. 76, and of new
læ in Draco and Cygnus taken by Dr. Roberts were projected
he screen, and the descriptive notes read by Mr. Maunder.
*he President.* I wish Dr. Roberts had been here this evening,
use he has been rather taken to task for being a little hyper-
cal in questioning the description that Sir John Herschel
l. He described it as "a cluster," which is, I venture to
k, the only way that it could be described. It is perfectly
that the cluster was large and compressed, equally true that
ncrease in the magnifying-power of the photographing instru-
t would separate the stars. This is a thing which would apply
ny cluster if a sufficiently large telescope were used.
vote of thanks was passed to Dr. Roberts.
*he President* then called on *Prof. Turner* to read his paper on
" Measurement of Paper Prints from Stellar Photographs."
*rof. Turner.* This paper is only a short preliminary note, but
ink it is not too early to call attention to the accuracy of the
lts which it is possible to get from the measures of photo-
hic prints. Up to the present time prints and lantern-slides
been regarded as beautiful pictures; but it has not been
idered that any very great astronomical accuracy is to be
ined from them without reference to the original negative.
shrinking of the paper in different directions has been
osed to affect the relative position of objects on prints, and
efore they have been regarded rather as pictures than as
tific records. At the same time we know that prints are
faithful representations of the subject. As in the case of a
rait, the likeness is not lost, although we know a skilful photo-
her can put the grain of the paper so as to make a long face
a wide one. I find on examination that the accuracy still
ined by a print is more considerable than has hitherto been
zed. To illustrate the fact that it has not yet been realized,
ould like to quote a passage from Dr. Gill's notes when the
inal project for the Astrographic Chart was being discussed.
Gill speaks of the possible reproduction in words of this
l:—"Copies of the Chart on glass would be a considerable

expense, and would be very inconvenient for many reasons. A simple method of reproduction would consist in making prints of the plates by photogravure or any other process, enlarging them to three diameters so as to have small stars visible, and then by compass and rule one could determine the position of the stars with considerable accuracy." Dr. Roberts has maintained the same proposition that on the print by using compass and rule—or, as he pertinently remarks, by having a sharp eye for alignment of stars—considerable accuracy in position can be obtained. But I do not think Dr. Gill or Dr. Roberts realize how great this accuracy may be. I was surprised myself when I measured the prints, with the *réseau* impressed upon them, to find how the malformation of the print is determined and can be eliminated by the *réseau* lines impressed upon the plates, which are some of those which have been taken for the Astrographic Chart. To put the result in definite words, the measures showed that in 70 cases out of 100 the print is quite equal to the original glass plate; in the 30 remaining cases there were considerable differences, some showing differences of star-places amounting to 3″. But I think if some attention were paid to the making of prints, it might be found possible to eliminate these exceptional cases. I would also take the opportunity of pointing out how much it would add to the value of *any* photograph if a *réseau* were imprinted on the plate before it was exposed to the sky.

*Prof. Darwin.* May I ask whether it was noticed if the axes of principal strain of the sheet of paper bore any fixed relationship to the length of the roll from which it was cut?

*Prof. Turner.* I am afraid I cannot answer that; I only made measurements of one or two prints; but I should be much obliged for any suggestions of that kind, for I think the whole thing should be investigated carefully. The measurements were made of prints that were lying about the observatory, and I thought I would take the worst cases first.

*Prof. Darwin.* You did not, I suppose, notice whether the axis of strain was parallel in different parts of the sheets?

*Prof. Turner.* No; there was no doubt about the difference in the stretching in the two directions; it was about 1·5 per cent. in one direction, and in the direction at right angles to the first only about 0·3 per cent.

*The President.* I have often noticed in drying prints that, while the body of the print is clear of water, there are two or three drops here and there which dry off much later. If this should happen when using paper, there would no doubt be an abnormal stretching somewhere, and it would be well to absorb all the superfluous water by blotting-paper first, and then dry it in not too rapid an atmosphere. All these things require consideration. There is no doubt that a thing which gives such consistent results in an ordinary way might with great care be brought to give very consistent results.

*Mr. R. A. Gregory.* What kind of paper did Prof. Turner use? There is a good deal of difference in the amount of stretching according to the kind of paper used. Was it the ordinary silver paper or was it home made?

*Prof. Turner.* The prints were platinotypes and were made in the ordinary way by a photographer in Oxford. I have every hope that with attention to the point mentioned the inaccuracies which have occurred in these exceptional cases may be got rid of; and I have called attention to this subject that all hands may be got to work upon it, because if a paper photograph can be produced which is of equal value with a glass plate, it is of great importance in relation to the convenience of circulating them.

*The President.* Now that Prof. Turner has set the ball rolling, I hope we may get some very excellent results from continuing the investigation of this matter.

A vote of thanks was accorded to Prof. Turner.

*The President* then asked *Father Sidgreaves* to exhibit some photographs of star-spectra which he had with him.

*Rev. W. Sidgreaves.* I brought these photographs here with me only to try, for my own information, whether they could be shown with the oxygen light; but as I am requested to do so, I am pleased to show them as specimens of the results obtained with the Stonyhurst spectrograph, which we have now got into adjustment quite to my satisfaction, because, as may be seen in this spectrum of Altair, which has been my test star throughout, the fine lines are shown between the hydrogen absorption-lines.

*Capt. Noble.* Can Father Sidgreaves tell us what is the cause of those longitudinal lines we see across the spectra?

*Rev. W. Sidgreaves.* I have had occasion to mention this before. These lines are seen on all photographs of spectra of stars which are taken without a slit. The spectrum is simply a *line* of colours, and it is made to travel broadside across the plate. If it were attempted to keep a star steady in the field it would actually have an oscillatory motion backwards and forwards. When the star is made to travel this becomes a halting motion, and there is therefore alternately a strong impression and a faint impression. When Sir Howard Grubb was at Stonyhurst he attributed this effect to "an inequality in the pitch of the worm-screw," and I have since noticed the same thing from screws of the best make.

*The President.* Has Father Sidgreaves determined the period of his clock corresponding to the distances between the lines?

*Rev. W. Sidgreaves.* It is about five minutes.

*Prof. Turner.* I had the pleasure of seeing Mr. McClean's telescope the other day. He finds the same appearance of horizontal lines in photographs of the spectrum. Since then I have made some experiments with the driving-screw of the Oxford equatorial, and have found that it has sufficient error to explain these. It is a comparatively small error; the screw makes complete revolution in 90 seconds, and an irregularity in the pi of the screw corresponding to 0·2 second would cause such stre and a well-made screw is liable to errors of this magnitude ( 'Observatory,' p. 320).

*The President.* I do not agree with Prof. Turner at all, beca he has not shown it is the screw that is to blame. Between regulating mechanism of the clock and the driving-screw ther a certain number of wheels, and it is far more likely, from engineering point of view, that the trouble should be in the wh than in the screw. The screw comes in for a great deal of bla but it is, I think, one of the most satisfactory things we have mechanism.

*Prof. Turner.* Mr. M^cClean gave the possible explanation t the screw might be perfect, but that the error might be due taking up one tooth after another by the screw.

*The President.* I do not hold with you there.

*Prof. Turner.* When the pressure is changed from one toot the next, there might be a loss of time.

*The President.* Yes, that is my point. But we are leaving main subject of Father Sidgreaves's excellent pictures. I thin he had put these plates in a little frame which had a slight up down motion these horizontal markings would have been elimina I believe this is a method which obtains in some foreign countr

A vote of thanks was accorded to Father Sidgreaves.

*The President.* You all know there will be an eclipse of the next year, and the opportunities for English people to see it in north of Norway are so favourable that it may be of great interes many to have some practical information as to the means of gett a chance of seeing the phenomenon. Several firms have m arrangements to send vessels to Norway, the first in the f being the Orient Steam Navigation Company (Messrs. Anders Anderson, & Co.), who will send a steamer to Vadsö or Vardö. T give exceedingly good accommodation, as would naturally be expec and their terms are 40 guineas for the trip of a month. Mes Gaze have also arranged to send a steamer, the 'Norse King,' have offered to take the expedition at a reduced rate. They h arranged that the steamer shall get to the point on Aug. 3, stay in the neighbourhood until the eclipse takes place five d later. This will give time for the putting up of the instrume There is another way by which observers who have less time their disposal can get to Norway, and that is from Newcastle the Matheson Line to Bergen or Bodö by the ordinary n steamer, which arrives at Vardö the night before the eclipse, any person who wants to see this glorious phenomenon, wh some of us will not have the opportunity of doing unless we do next year, will do very well to go by that route. I have no do that all the Members of this Society will be able in a short time have full particulars of all these various ways of getting there, and they can then select the line which suits them best. As to what the Permanent Eclipse Committee propose to do, I hope at the next Meeting, with the help of Prof. Turner, to show you some instruments which it is proposed to employ, particularly one especially adapted for eclipse work—I mean the cœlostat, an old instrument which has lately been revived by M. Lippmann of Paris. The Eclipse Committee hope to be able to send expeditions to both Japan and Norway.

*Mr. Lewis* then read a paper on the "Orbit of Struve 1879," the observations of which binary star he said were very scarce. During the past summer he had opportunities of observing it with the 28-inch Greenwich refractor.

*Dr. Spitta.* The Astronomer Royal recently showed me this star through the new telescope. The remarkable appearance of this star struck me immediately on looking through the telescope. Often one has to look a considerable time before it is possible to see details of an object, but the duplicity of this was apparent at the moment, and one could see without any adjustment how very neatly defined the components were. There was a good deal of tremulation, but the telescope seemed to perform excellently.

*Mr. Dyson* then read a paper, communicated by the Astronomer Royal, on the "Diameters of Saturn and its Rings about Opposition during 1895." The observations were made with the 28-inch refractor. The full aperture was used, and the magnifying-power was 670, and occasionally 1000. Most of the measures were made by Mr. Lewis; the definition of the ring was very good, Cassini's division being easily seen. Encke's division was seen by the Astronomer Royal and by Mr. Lewis, but not measured. There was in general a close agreement in the results as determined at Greenwich, at the Lick Observatory, and at Washington, the only discordance being in the polar diameter. At Greenwich not many measures were made of the polar diameter, and it was proposed if possible at the next opposition to get a few more measures so as to make the set more complete.

*Dr. Spitta.* I should like to ask Mr. Dyson whether he had tried measuring Saturn as seen in a field lighted by monochromatic light. I ask because during one opposition I spent some time in measuring the satellites of Saturn, but I was so surprised at the discordance of the results that they went into the waste-paper basket. Since then I have been observing with a screen, and the accordance of the measures made under monochromatic light is remarkable. It is a very soft light to the eye.

*Mr. Dyson.* We have tried it in the case of double-star measures.

*Capt. Noble.* May I call attention to an article on this subject in the current number of the 'Observatory'? It treats of the hypothesis of Struve that the ring-system is shrinking on to the planet. If Struve's hypothesis be correct, in the year 2250 the whole system will have closed in on the planet. There is another instructive thing in that article to which I might refer, and that is with reference to a subject I have alluded to in this room, namely that the measures of Saturn made by the double-image micrometer are so very much in excess of those taken by the filar micrometer. That point deserves following up. One of the two is a very untrustworthy instrument; they cannot both be right.

*A Fellow.* Perhaps they are both wrong.

*Mr. W. W. Bryant.* With regard to the discordance in the polar diameter, is it not possible that because of the tilt of the planet shown by the opening out of the rings, which is greater than during last year, we should expect the polar diameter as measured this year at Greenwich to be greater than the diameter measured last year in America?

*Mr. Lewis.* The measures given in the paper have been corrected for the effect of the elevation of the Earth above the plane of the Ring.

*Dr. Downing.* I hope in future that Greenwich observers will be able to pay some attention to the measures of position of the satellites. I have lately been engaged in preparing an ephemeris of the satellites of Saturn for the 'Nautical Almanac,' and I confess that I have had some difficulty owing to insufficient data. I think if observers were to devote themselves to measures of the position of Hyperion they would be repaid for any labour they bestowed. I should be exceedingly glad of a continued series of observations of this satellite at the present time.

*Mr. Dyson.* Some double-image micrometer measures of Jupiter have been made. The measuring of positions of satellites like Hyperion would no doubt be an interesting and valuable work, but before undertaking it we should like to have from Dr. Downing some data as to what measures are especially wanted.

*Dr. Downing.* With regard to the satellite Hyperion, I should think observations of position-angle and distance at any time would be valuable. The closer satellites can only be measured at elongation, but it would not be lost labour to measure the position-angles and distance of the other satellites whenever the weather is clear enough.

*The President.* With regard to what Dr. Spitta said about measuring Saturn under monochromatic light, I do not know whether the effect of a violet screen has been tried at Greenwich, which would, I think, naturally increase the defining-power of the telescope very largely, and much more so than a red screen, which I consider to be the worst form of screen. One could not look at the table which has just been exhibited without noticing the accordance of these very delicate measures. We cannot but feel delighted with the very excellent results obtained at Greenwich, which may be attributed, not only to the excellence of the telescope, but also to the excellence of the observers.

*Mr. Lewis.* We have used a violet screen for measuring double stars at Greenwich and we found it better than the red.

*Mr. Maunder* (presenting a paper from the Royal Observatory, Greenwich). This is the usual annual summary of the results of our measures of solar photographs. The principal interest of 1893 is that it was the year of sun-spot maximum. That is shown in two ways. The mean daily total area of sun-spots was considerably larger in 1893 than in 1892, and the mean latitude had decidedly decreased. It had come down to the point which the sun-spots usually occupy at maximum, about 15°. The maximum for the northern hemisphere happened in 1892, that for the southern hemisphere in 1893, and the predominance of the spots in the southern hemisphere was so great that it more than counterbalanced the diminution of the spots in the northern. There was a decrease of faculæ in 1893, so I think on all grounds we may put the time of maximum solar disturbance as August 1893, for immediately after the great outburst of August had finished the spots assumed a lower latitude and there has been no outburst of equal importance since then.

*The President.* Mr. Maw and Capt. Hills are present, and I will ask them to give us some account of their work in connection with the Photographic Committee of the Society, which exists for the purpose of making reproductions of such photographs as come into our possession, which reproductions are then published and sold at a small cost. These gentlemen have been at work in a most praiseworthy manner with most excellent results, and it will shortly be possible for any Fellow of the Society to buy a print or a lantern-slide of nearly every photograph they have seen in this room or which they may know of. We have a most excellent collection of original photographs, which is added to day by day, and we hope to extend this so as eventually to include every existing astronomical photograph considered worth having.

*Mr. Maw.* During last season the Council voted £20 to be expended in experiments for the reproduction of photographs for the Society. Capt. Hills and I were asked to make some experiments as to the best methods of reproduction, and we selected a dozen of the pictures belonging to the Society, and had negatives made from the positives by two processes—platinotype and aristotype. What we had done was described in the June number of the 'Monthly Notices,' and a large number of these prints were sold. In September we chose an additional number of photographs for reproduction, making the total up to 19. A set of prints by both processes will be shown in the library. We shall be glad to receive hints from Fellows as to how they can be improved. We want to reproduce the pictures for which there is the greatest demand. The prints will be supplied at *1s. 6d.*, lantern-slides at 1*s.* each, to Fellows of the Society.

*Prof. Turner.* I must express my satisfaction that we have at last got some machinery at work for the reproduction of astronomical photographs. It may not perhaps be realized by Fellows generally that the delay in getting this machinery in motion is partly due to the fact that a new Executive is necessary for a new move of this kind. The ordinary business of this Society is conducted by the Secretaries, but new matters arise which it is not possible for the Secretaries to undertake. We have had the business connected with the lantern introduced lately, the success of which is chiefly due to Dr. Spitta. Now we have a new business again, which hung fire until Mr. Maw and Capt. Hills came to the rescue.

[The series of lantern-slides were then shown on the screen.]

*The President.* You will see that the Photographic Committee have not confined themselves to any one branch of astronomy in selecting subjects for reproduction; and it will not be long before a man who has a particular line, such as nebulæ, star-clusters, the Moon, or any other, will be able to get a complete series of pictures illustrative of the subject he is interested in.

Vote of thanks was accorded to Mr. Maw and Capt. Hills.

The following papers were announced and partly read:—

*E. E. Barnard.* "Measures of the Diameters of Ceres, Juno, and Vesta, made with the 36-in. Equatorial of the Lick Observatory."

*E. E. Barnard.* "On the extended Nebulosity about 15 Monocerotis."

*E. E. Barnard.* "Invisibility of Hind's Variable Nebula."

*F. Valle.* "Observations of Encke's Comet and of Minor Planets at the National Mexican Observatory."

*Prof. E. W. Brown.* "Note on Hansen's Lunar and Planetary Theories."

*J. Tebbutt.* "Micrometer Comparisons of Saturn and 96 Virginis, &c."

*Isaac Roberts.* "Photographs of the Nebulæ H VI. 41, H VIII. 76, and of New Nebulæ in Draco and Cygnus."

*Lt.-Col. E. E. Markwick.* "Observations of the Variable Star T Centauri."

*Royal Observatory, Greenwich.* "Mean Areas and Heliographic Latitudes of Sun-spots in the year 1893."

*Royal Observatory, Greenwich.* "Diameters of Saturn and his Rings during the Opposition of 1895."

*Dr. T. J. J. See.* "Note on the Discovery of the Graphical Method of solving Kepler's Equation."

*P. H. Cowell.* "Note on the Value of the Longitude in the Lunar Theory when the Sun's Mass is put Zero."

*T. Lewis.* "The Orbit of Σ 1879."

*Prof. H. H. Turner.* "Note on the Measurement of Paper Prints of Stellar Photographs."

The following gentlemen were elected Fellows of the Society:—

*Antoine d'Abbadie*, 120 Rue du Bac, Paris; *Loyal H. Bradford*, North Ferrisburgh, Vermont, U.S.A.; *Oswald Thomas Tuck*, School-ship 'Conway,' Birkenhead.

The following Candidates were proposed for election as Fellows of the Society:—

*Hugh Lancelot Aldis*, Secretary of Public Company, 67 Dieppe Street, West Kensington, W. (proposed by E. J. Spitta).

*William Ernest Cooke, M.A.*, First Assistant Astronomer, Adelaide Observatory (proposed by Sir C. Todd).

*Alpin G. Fowler, M.Inst.C.E.*, Civil Engineer, 1 Cambridge Road, Norbiton (proposed by W. H. M. Christie).

*David Edward Hadden*, Alta, Buena Vista Co., Iowa, U.S.A. (proposed by L. A. Eddie).

*Rev. Robert Killip*, Sale, Manchester (proposed by Sir R. S. Ball).

*George Handley Knibbs*, Lecturer on Surveying, University of Sydney, New South Wales (proposed by R. T. A. Innes).

*Frederick William McCarthy*, 20 Chepstow Place, Bayswater, W. (proposed by J. McCarthy).

*Charles J. Merfield*, Department of Public Works, Sydney, New South Wales (proposed by R. T. A. Innes).

*Hugh Griffith Quirk*, Master Mariner, Baymount, Vico Road, Dalkey, Co. Dublin (proposed by S. M. Yeates).

---

## THE BRITISH ASTRONOMICAL ASSOCIATION.

THE Annual General Meeting of the British Astronomical Association was held at University College, Gower Street, on Wednesday, October 30, the President, Mr. E. Walter Maunder, in the Chair.

The Scrutineers reported that the following ladies and gentlemen had been elected as Council for the ensuing session:—*President*, Mr. E. Walter Maunder; *Vice-Presidents*, Dr. A. M. W. Downing, Capt. W. Noble, Dr. Isaac Roberts, and the Earl of Rosse; *Treasurer*, Mr. W. H. Maw; *Secretaries*, Miss Everett and Mr. J. G. Petrie; *Librarian*, Mr. F. W. Levander. *Other Members of the Council*, Rev. J. L. Cortie, Messrs. G. T. Davis, P. F. Duke, N. E. Green, E. Holmes, T. Lewis, G. J. Newbegin, D. Smart, and W. H. Wesley. The President announced that the following appointments had been made by the Council in accordance with the new Rules:—*Editor*, Miss A. S. D. Russell. *Directors of Observing Sections*: *the Sun*, Miss Brown; *the Moon*, Mr. T. G. Elger

*Mercury and Venus*, Mr. H. MacEwen; *Jupiter*, Rev. W. R. Waugh; *Saturn*, Mr. N. E. Green; *Comets*, Mr. W. E. Plummer; *Meteors*, Mr. H. Corder; *Star Colours*, Mr. G. F. Chambers; *Variable Stars*, Mr. J. E. Gore; *Double Stars*, Mr. G. M. Seabroke; *Spectroscopy*, Mr. J. Evershed, Jun. The appointments having been unanimously confirmed by the Meeting, the Treasurer presented the annual accounts, which showed an increase both in the reserve fund and in the balance to the credit of general revenue account.

*The President* then delivered the usual annual address to the Association. He alluded in the first place to the very valuable services rendered to the Association by Mr. Levander and Mr. Wheeler, the Hon. Librarian and the Hon. Curator of the lantern-slide department. The work in both departments had been very heavy during the past year. He congratulated the Meeting on the very remarkable progress of the Association, two hundred new members having been added during the session, raising the total membership to over 1000. The address related chiefly to the total solar eclipse of August 9, 1896, and the best methods of observing it. The Meeting was reminded that the occasion was an unusually favourable one for English astronomers, and the hope was expressed that a considerable number of Members would avail themselves of the opportunity and would join the expedition to Vadsö which a Committee of the Association were endeavouring to organize. All observers were recommended to take out some instrument if possible, a good spectroscope being the most desirable instrument. The work of the observer with the spectroscope might be divided into three parts: (1) before totality, watching for the appearance of bright lines beyond the limb of the Sun still uneclipsed; (2) during totality, searching for bright lines in the spectra of special prominences or selected regions of the corona; (3) after totality, recording the fading-out of bright lines beyond the limb of the Sun first uncovered. To do any useful work in either field it would be essential that the observer confined himself rigidly to one small section of the spectrum, with the appearance of which he must have perfectly familiarized himself by long and repeated study.

Telescopes would be useful for two purposes—(1) the determination of the times of contact, and particularly of the times of the commencement and ending of totality; (2) the sketching or description of some one feature of the corona. Remembering that only 106 seconds were available, it would be absolutely impossible for anyone in that time to sketch the whole corona, or even any considerable part. To attempt it would be to lose everything. But beyond question the photographic plate would do the best work under this head, and probably one of the best uses to which even an ordinary refractor could be put would be to adapt it for photographic work; and in this connection the President put in a plea for the old wet-plate collodion process in the case of any Members who might skilled in that old-fashioned method. There would be plenty work for observers without instrumental equipment, not only assisting the fortunate possessors of instruments, but also in dependent observation. Drawing the corona, for which most reful preparation and training would be necessary; general servations of the appearance of objects as the eclipse came on; the breadth, distance apart, and velocity of the shadow-bands; arching for comets or a possible intra-Mercurial planet; and awing the outer corona, the inner corona being screened by a sk—were some of the departments of work suggested. In conusion, the absolute necessity of careful preliminary training and hearsals were insisted on.

After the address a photograph of the eclipsed Sun with the rona, reduced to reproduce the actual size and appearance of the enomenon, was thrown on the screen for the exact period of e eclipse—106 seconds.

A very hearty vote of thanks, proposed by Dr. Downing and conded by Dr. Roberts, was given to *Miss Everett*, who had en compelled to resign the Secretaryship owing to removal from ndon. Votes of thanks to the retiring Members of Council, e Auditors, and the Scrutineers of the ballot concluded the siness of the Meeting.

## ROYAL METEOROLOGICAL SOCIETY.

E opening Meeting of the Session was held in the new building the Institution of Civil Engineers, on Wednesday evening, Nov. th, Mr. R. Inwards, F.R.A.S., President, in the Chair, when a per by Mr. J. Eliot, F.R.S., was read, "On the Origin of the Coldather Storms of the Year 1893 in India, and the character of the r-movement on the Indian Seas and the Equatorial Belt, more ecially during the South-west Monsoon Period." This was lly a discussion of the data contained in the *Indian Monsoon ea Charts*, the publication of which was sanctioned by the dian Government for the two years 1893–4. Cyclonic storms are frequent occurrence during both the N.E. and the S.W. monsoons, t they differ in many important respects. The storms of the W. monsoon originate almost invariably over a sea-surface, and avel in very variable directions, and occasionally develop into tense and furious hurricanes. The cyclonic storms of the N.E. onsoon almost invariably originate over the plateau of Persia or luchistan or in North-western India, and travel in an easterly rection at a velocity ranging between 15 and 20 miles per hour. ese plateau-formed storms of the cold weather are the chief struments of the distribution of the moderate rainfall essential for e great cold-weather wheat and other crops of Northern India, d are the chief sources of the snowfall of the Western Himalayas.

After giving an account of the more important cold-weather storms in January and February 1893, and the results of the tabulation of the wind observations for the equatorial belt, the author describes the "burst of the Monsoon." Mr. Eliot says that the evidence of the year 1893 is strongly in favour of the supposition that the S. W. monsoon currents in the Indian Seas are the direct continuation north of the equator of the horizontal movement of the S.E. trade-winds; and that the larger variations in the strength of the S.E. trades near the equator during the monsoon period are reproduced in the monsoon currents in the Indian Seas from June to September.

Mr. W. H. Dines showed a very interesting and instructive experiment illustrating the formation of the tornado cloud. The characteristic funnel-cloud was readily seen extending from the tray of hot water to the mouth of the pipe at the top of the box, and when the draught was strong and the conditions favourable, a decided protuberance was observed on the surface of the water just under the end of the cloud. Mr. Dines is of opinion that the cloud is formed by true dynamic cooling as the air saturated by the vapour from the hot water comes under the influence of the decreased pressure at the centre.

A paper by Mr. C. Davison, F.G.S., was also read, "On the Diurnal Variation of Wind Velocity at Tokio, Japan."

---

## *On the Number of Figures necessary in Reductions of Apparent Star-places.*

In the last number of this Magazine (p. 391) the Radcliffe Observer gave his reasons for retaining the use of 5-figure logarithms in computing star-corrections, whereas I was inclined to think 3-figure logarithms (and in some cases 2-figure) are sufficient. Having examined the points in question with some care, I hold to this opinion, for reasons given below.

The calculation of a star-correction as performed by Mr. Stone's tables is made by adding together five terms

$$Aa + Bb + Cc + Dd + C \,.\, Sc$$

for the Right Ascension, and

$$Aa' + Bb' + Cc' + Dd' + A \,.\, Sa'$$

for the Declination. It is more convenient to consider the second expression first, for its value in arc of a great circle does not alter with proximity to the Pole.

Let us first see what is the maximum error in each term introduced by restricting the logarithms used to three figures. The term $Aa'$ or $A \sin \alpha \sin \delta$ is found by adding the logs. of A, $\sin \alpha$ and $\sin \delta$. If we restrict these to three figures, each log. *may* be in error by ·0005 as a maximum; and if all the errors are at their maximum and in the same direction (a very rare occurrence), the sum will be in error by ·0015. Now this will produce the greatest error in the number when the number is large, as shown in the following short table:—

E = error in A*a*′ corresponding to error of ·0015 in log (A*a*′).

| A*a*′ = | 0″ | 5″ | 10″ | 15″ | 20″ |
|---|---|---|---|---|---|
| E = | 0″·00 | 0″·02 | 0″·03 | 0″·05 | 0″·07 |

It is unnecessary to go beyond 20″, for A*a*′ is never so large as 20″, its greatest value being about 18″.

The case of B*b*′ is precisely similar, the maximum value of the term being 20″·5.

The terms C*c*′, D*d*′, and A S*a*′ are products of two terms only, *viz.*, C cos *a* and D sin *a*. The greatest error in their logs. is thus only ·0010; but the term C*c*′ may be as great as 30″ nearly. The greatest possible error in C*c*′ from restricting the logs. to three figures is 0″·07; in D*d*′ or A . S*a*′ is 0″·03.

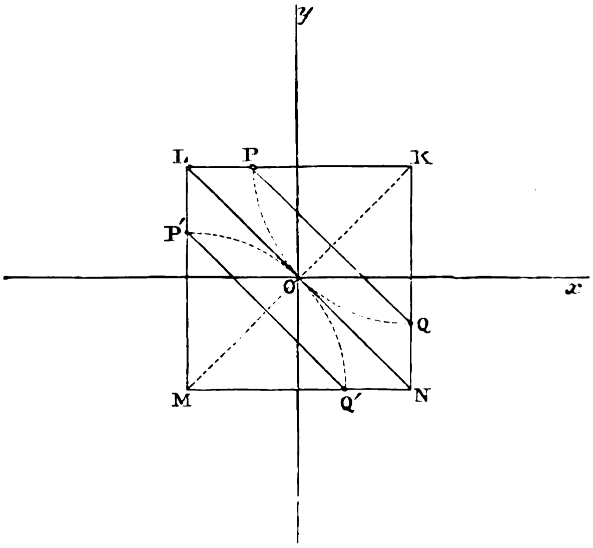
Now in the extremely unlikely case when *all these errors were at their maximum and all in the same direction*, we should get a resultant error in the star-correction of

$$0''{\cdot}07 + 0''{\cdot}07 + 0''{\cdot}07 + 0''{\cdot}03 + 0''{\cdot}03 = 0''{\cdot}27.$$

But such a case of accumulation of errors is so rare as to be quite negligible in practice—like holding 13 trumps at whist. The vast majority of errors are less than one-tenth of this quantity. To find the law of distribution is a complicated business, but a rough estimate may be made without much trouble.

Let us recur to the original logarithms of, say, A, sin *a*, and sin δ. If each of these is restricted to three figures, it may be in error by ·0005 in excess, or ·0004 in defect. Thus ·3845 would be written ·385, but ·3844 would be written ·384. Between these limits the error may have any value indiscriminately. The average error is thus +·00005; and when three logarithms are added together the average error of the sum is +·00015. This is a small quantity, but is a systematic error, and as such is worthy of attention. It corresponds to an error of ·04 per cent. in the number A sin *a* tan δ. Thus when A sin *a* tan δ = 20″ the average error is 0″·01 and not 0″·00. In an actual example given below we shall see the significance of this systematic error.

But putting this aside for the moment, let us assume that the errors are symmetrically distributed about zero, from −·0005 to +·0005, and suppose in the first place we add together *two* logs., and let the errors be *x* and *y*, where *x* and *y* may have any value from −·0005 to +·0005 indifferently. If we represent them as Cartesian coordinates, the point (*x*, *y*) will lie within a square K, L, M, N. The extreme error of the sum ·0010 corresponds to the positions K and M, when *x* and *y* are both +·0005 or −·0005. The error is zero along the line LN, and constant along lines parallel to it. If we take as the "probable" error that which is as often exceeded as not, then we must draw lines P Q, P'Q' [illegible] so that the area PLP'Q'NQP is half that of the square; and then the "probable" error is that represented by the lines PQ or P'Q'. This gives at once $2KP^2=KL^2$; and the "probable" error bears to the extreme error at K the ratio LP to LK; or $\sqrt{2}-1$ to [illegible] $\sqrt{2}$; or ·414 to 1·414; or ·34. The extreme error being ·0010, the "probable" error is thus ·0003.



Had we added three logs. together we should have got for [illegible] the ratio of "probable" to extreme error about ·30 or less.* [illegible] And the extreme error being ·0015, the "probable" error is ·0005.

It follows that the maximum "probable" errors of the [illegible] five terms, *Aa'*, *Bb'*, *Cc'*, *Dd'*, and *ASa'* are respectively 0″·021, 0″·0[illegible] ·021, 0″·023, 0″·010, and 0″010.

To determine the "probable" error of the sum of the fi[illegible] five terms is more difficult, for the terms differ in character. But [illegible]t as a rough approximation let us assume that each term has an err[illegible] error which may have all numerical values indifferently from 0″·000 [illegible]oo to 0″·050 (the mean being 0″·025, which is greater than all the abo[illegible] bove probable errors). Then the "probable" error of the sum wi[illegible] will bear to the extreme error 5×0″·025 or 0″·0125, a ratio of abo[illegible] bout ·20; or the "probable" error of the result is about 0″·025.

Rough as is this estimation, I think it is sufficient to sho[illegible] show that an accumulation of errors, owing to a restriction to 3-figure logs., amounting to anything like 0″·10 would be of very rare occurrence. There are other circumstances tending to diminish such accumulations which have not been yet noticed—such as the fact that $Aa'$ and $Bb'$ cannot have their maximum values simultaneously.

---

* The calculation for three or more terms added together becomes som[illegible]ome what complicated. I have followed it sufficiently to get a rough notion of th[illegible] of th[illegible]e fa ratio of the probable to extreme error up to five terms; but the details are fa[illegible] too long to give here.

Turning now to the star-corrections in R.A. we are confronted with the factors tan $\delta$ and sec $\delta$. One form of the correction is

$$\Delta a = f + g \sin (G+a) \tan \delta + h \sin (H+a) \sec \delta.$$

But we may write

$$\Delta a \cos \delta = f \cos \delta + g \sin (G+a) \sin \delta + h \sin (H+a),$$

and $\Delta a \cos \delta$ is now expressed in arc of a great circle, instead of the misleading unit which changes its value as we approach the Pole. In this form the correction closely resembles the Declination correction

$$\Delta \delta = i \cos \delta + g \cos (G+a) + h \cos (H+a) \sin \delta,$$

and all that has been said above about limiting errors applies to it almost exactly. Hence, though we may *appear* to be making large errors in R.A., they are not really larger in arc of a great circle than those above determined.

If this reasoning is correct, by using 3-figure logarithms we may expect half our errors to be less than 0″·02. The majority of the other half exceed 0″·02 only slightly, the number of errors of any given value diminishing very rapidly as this value exceeds 0″·02.

By using 2-figure logs. we may expect half our errors to be less than 0″·20. The majority of the other half exceed 0″·20 only slightly.

In both cases the errors are of the same character as accidental errors, and when we consider the probable error of an observation, it seems to me that nothing much would be lost by restricting the calculations *to 2-figure logs.*, allowing the errors introduced to rank as accidental. Certainly *3-figure logs.* ought to suffice.

Theoretical reasoning about such a matter is not, however, wholly satisfactory, unless supplemented and confirmed by experiment. When I had written thus far, I applied to the Astronomer Royal for permission to examine some actual star-correction books and try the effect of restricting the figures in practice. He kindly sent me two books at once; the calculations in these books have been already made with 4-figure logarithms, and each contains the calculations for a good many miscellaneous stars observed near the end of the year 1893. I purposely asked for books of date near the end of a year because the star-corrections are then largest (owing to the effect of precession) and discrepancies would be also largest.

Taking the first 100 stars in one of these books, and restricting logs. to 3 figures, and comparing the results with those obtained viously, I find differences in *Declination* corrections as follows:

| Error. ″ | Number of cases. | Error. ″ | Number of cases. |
|---|---|---|---|
| −0·05 | 1 | +0·01 | 5 |
| −0·04 | 6 | +0·02 | 9 |
| −0·03 | 11 | +0·03 | 6 |
| −0·02 | 11 | +0·04 | 3 |
| −0·01 | 32 | +0·05 | 1 |
| 0·00 | 15 | | — |
| | | Total.... | 100 |

The small systematic error previously mentioned is conspicuous in this example.

Many of the star-corrections about this period have values near −20″, and the errors are thus grouped about a mean somewhere near −0″·01. Also it will be noticed that about half the errors (viz., 52 out of 100) are less than 0″·02. It would perhaps be fairer to count not those which differ from *zero* by less than 0″·02 numerically, but those which differ from the mean value −0″·01 by less than this amount: *i.e.* those which have values −0″·02, −0″·01, and 0″·00, and of these we have 58 cases out of 100. Thus the rough estimation of probable error above made is confirmed in this example.

Proceeding to the R.A.s, I considered the errors in two ways: Firstly, taking them as they stand, without reduction to the equator. The stars selected are particularly unfavourable to this method, being mostly Groombridge stars of high declinations—some within 10° of the Pole. The 100 errors are distributed as follows:—

| Error. s | No. | Error. s | No. |
|---|---|---|---|
| −0·003 | 3 | +0·004 | 13 |
| −0·002 | 0 | +0·005 | 11 |
| −0·001 | 5 | +0·006 | 9 |
| 0·000 | 1 | +0·007 | 15 |
| +0·001 | 8 | +0·008 | 4 |
| +0·002 | 7 | greater | 10 |
| +0·003 | 14 | | —— |
| | | Total .... | 100 |

Of these 49 out of the 100 exceed $0^{s}{\cdot}004$, and thus rank as $0^{s}{\cdot}01$ by "raising." It does not, however, always follow that a difference of (say) $0^{s}{\cdot}007$ would alter the star-correction in the second place of decimals. Thus $4^{s}{\cdot}835$ and $4^{s}{\cdot}835+0^{s}{\cdot}007$ both rank as $4^{s}{\cdot}84$. On the other hand a difference of $0^{s}{\cdot}001$ is sometimes sufficient to alter the second place: thus $4^{s}{\cdot}835-0^{s}{\cdot}001$ ranks as $4^{s}{\cdot}83$. On re-examining the individual cases, however, I found that the number altered by $0^{s}{\cdot}01$ was very nearly the same as above, viz., 48 out of the 100 remained exactly the same to the two places of decimals as before: 47 were altered by $+0^{s}{\cdot}01$, two by

$-0^{s}{\cdot}01$, two by $0^{s}{\cdot}02$ (declinations $+71^{\circ}$ and $+83^{\circ}$), and one by $0^{s}{\cdot}03$ (declination $+79^{\circ}$). The largest actual error found was $+0^{s}{\cdot}023$ at declination $+79^{\circ}$, equivalent to $0^{s}{\cdot}005$ at the equator. Reducing all these to arc at the equator they become as below:

| Error.<br>s | Number of cases. | Error.<br>s | Number of cases. |
|---|---|---|---|
| −·003 | 1 | +·003 | 18 |
| −·002 | 1 | +·004 | 6 |
| −·001 | 5 | +·005 | 15 |
| ·000 | 3 | +·006 | 13 |
| +·001 | 13 | +·007 | 5 |
| +·002 | 20 | | |
| | | Total .... | 100 |

The general result is that the star-corrections in these 100 cases taken at random are *sensibly correct to* $0^{s}{\cdot}01$ *and* $0''{\cdot}05$ *when the logarithms are restricted to three figures.* This is my main proposition. But I am fully conscious that it is not sufficient to establish this proposition theoretically. All working astronomers are familiar with the inevitable disadvantages attending change in a well-established system, however clear the advantages of the innovation may be on paper. Mr. Stone's tables have been in use for many years at different observatories, and are undoubtedly a great advance on what preceded them. They are available, as he has remarked, for other computations than star-corrections, and must not be judged purely from the standpoint of utility for this particular purpose. For this purpose I think they can be improved, and I trust I have shown good cause for the opinion. I have set about preparing more concise tables in accordance with the principles above discussed, and when these have been tried practically it will be time to enquire whether they are to be preferred to those of Mr. Stone, which have worked so well. I hope that the tables will be considerably more compendious; for I think that in "extending his tables sufficiently to avoid the necessity of interpolations" Mr. Stone has gone too far. For instance, the R.A. table is extended to a great length near $0^{h}$, the quantities being tabulated here for every $1^{s}$ of time, while $10^{s}$ is considered sufficient near $\text{III}^{h}$. This is because the differences of log sin $a$ change rapidly near $0^{h}$. But is not the fact overlooked that since sin $a$ is very small, the differences *do not really matter?* *i. e.* they do not affect the final result? Thus we have a piece of the table as follows:—

| R.A. | | | *b* or *c*. |
|---|---|---|---|
| $0^{h}$ | $0^{m}$ | $10^{s}$ | 6·86167 |
| | | 11 | 6·90306 |
| | | 12 | 6·94085 |
| | | 13 | 6·97561 |
| | | 14 | 7·00779 |
| | | 15 | 7·03776 |
| | | etc. to | |
| | | 20 | 7·16270 |

But suppose we used the quantity for $0^h\,0^m\,20^s$ instead of $0^h\,0^m\,10^s$, what difference would it make? The logarithm is to be added to another which cannot be greater than about 1·40000 (in declination, or if in R.A. then reduce to equatorial arc); and the mistake of using 7·16270 for 6·86167 would make a difference of $0''{\cdot}018$ only in the final result. In fact, if we wish to tabulate log sin $\alpha$ so that when used to find $k \sin \alpha$ (where $k$ is independent of $\alpha$) the tables shall give the result with uniform correctness for all values of $\alpha$—say to 0·001—then if $\Delta\alpha$ be the interval between two tabulated values of $\alpha$ we have

$$k \cos \alpha\, \Delta\alpha = {\cdot}001,$$

$$\Delta\alpha \propto \sec \alpha,$$

and

$$\Delta\,(\log \sin \alpha) \propto \frac{\cos \alpha}{\sin \alpha}\,\Delta\alpha \propto \operatorname{cosec} \alpha.$$

Thus if $10^s$ is sufficient at $\mathrm{III}^h$ where $\cos \alpha = {\cdot}7$, then $10 \times {\cdot}7$ or $7^s$ is sufficient at $0^h$ where $\cos \alpha = 1$.

With some of Mr. Stone's statements I fear I cannot agree. For instance, when he says that logarithms are taken out directly to the fifth place "because it is found to take less time to enter the extra figures than to contract them before entry" (Observatory, No. 233, p. 391). I really cannot subscribe to this. The amount of thought and delay required by a practised computer to contract a figure is almost insensible: that required to deal with the figure when so written down—say to add it to another and write down the result—is sensible. H. H. TURNER.

---

## *Some Astronomical Records in ancient Chinese Books.*

[Continued from p. 358.]

WE meet with no more astronomical references in ancient Chinese books till the beginning of the Chou dynasty. There is a fragment of a book called the 'Chou Shu,' the book of the Chou dynasty. It is said that it was found during the Yin dynasty in the reign of T'aï K'ang, about 280 A.D., in the tomb of An[1] li[2] wang[2] of the Wei country. It must be confessed it looks a little suspicious, this tale of recovering books in the tombs of people long since dead. I am not capable of criticizing the age of a Chinese book from a literary standpoint, but the astronomical references in the book seem to be capable of verification. I do not think it is a forgery; if it is, it is a clever one.

In this book it is stated that in the 35th year of Wen Wang, on the day ping[3] tzu[3], there was an eclipse of the Moon. That day is the 13th of the cycle of 60 days. I find by calculation that, on

January 29, 1136 B.C., the Sun and Moon were in opposition in longitude at about 10 P.M., Lo yang mean time. At opposition the Sun was only 28° from the node, so that the eclipse was total. January 29 was the 12th of the cycle of days, but according to Gaubil, in the Chou dynasty, the Chinese began their day at noon. This would make the eclipse occur on the 13th day. In any case, as the eclipse occurs so near midnight, the year 1136 fully satisfies the conditions of the narrative. Other astronomical references, however, in both the 'Chou Shu' and the 'Shu Ching,' indicate that this eclipse occurred, not on the 35th, but on the 37th year of Wen Wang.

Thus we have verified a total eclipse of the Moon, during the 37th year of Wen Wang, as occurring on January 29, 1136, on the day ping$^3$ tzu$^3$. Wen Wang reigned over his principality 50 years, so that the year 1122 B.C. was the first year of Wu Wang and the year 1110 B.C. his 13th year. It was on this year, according to the 'Shu Ching,' that Wu Wang set out to attack Chou Hsin, the last emperor of the Shang dynasty.

It is also stated in the 'Chou Shu' that in the 3rd year of Wu Wang the first day of the second month was the day ping$^3$ ch'ên$^2$. According to the above chronology, the 3rd year of Wu Wang was the year 1120 B.C. I find on that year that the 1st of the second month began on Feb. 15 at 8.30 P.M. G.T. Now, Feb. 15 was the day ping$^3$ ch'ên$^2$. Of course, in China the new Moon occurred after midnight, but we need not look for great accuracy in Chinese determinations of new moons at that remote period. Thus the text of the 'Chou Shu' is again verified.

It says in the 'Shu Ching' that, in the first month, the day jên$^2$ ch'ên$^2$ was the day after the end of the Moon's waning; that, on the next day, Wu Wang set out to attack Chou$^4$ Hsin; on the day ya$^4$ wu$^3$ he halted on the north of the river, and that the day chia$^4$ tzu$^3$ was the day of battle. In the 4th month, the 3rd day of the month he returned from the battle, and on the day ting$^1$ mo he sacrificed at the ancestral temple of Chou. Now, I find that the above days are satisfied very well by the year 1100 B.C., but not by the year 1121 B.C., which the common chronology gives as the first year of Wu Wang's reign over the empire and the 13th year of his reign over his principality.

I find, however, that the Chinese astronomers were a month wrong in their reckoning. What is stated in the 'Shu Ching' as the first month was really the 12th month. It will be remembered that, according to the Chou calendar, the first month is that which contains the winter solstice, that is the 11th month according to the present calendar.

Now, November 28, 1111 B.C. was the 1st of the month and the day kêng$^1$ yin$^2$. The 3rd of the month, that is near about the day after the Moon's waning, was the day jên$^2$ ch'ên$^2$. This agrees very well with the text. The longitude of the Sun at conjunction was only 236° 38′, so that this month could not contain the winter solstice. It was really the 12th month, but the Chinese wrongly reckoned it as the first month.

On November 30, 1111 B.C., therefore, Wu Wang set out to attack Chou Hsin. On the 29th of the first month, December [illegible], the day ya$^4$ wu$^3$, he halted on the bank of the river. The 5th of the second month, corresponding to January 1110 B.C., the day chia$^3$ tzu$^3$, was the day of battle. On the 3rd of the 4th month, March 28, he returned a conqueror from the battle, and on April 14, the 20th of the 4th month, the day ting$^1$ mo$^4$, he sacrificed at the ancestral temple. There must have been an intermediate intercalary month, as otherwise the 4th month could not have contained the day ting$^1$ mo$^4$.

The common chronology gives the year 1121 B.C. as the first year of Wu Wang's reign, but this date does not agree either with the eclipse of the Moon mentioned in the 'Chou Shu' nor with the days as mentioned in the 'Shu Ching.' Thus I find that Nov. 30, 1122 B.C., was the first day of the Moon and was the day chia$^3$ wu$^3$; so that, in the year 1122 B.C., the day jên$^2$ ch'ên$^2$ occurred two days before the end of the Moon, instead of two days after, as the text in the 'Shu Ching' requires.

The records in both the 'Chou Shu' and the 'Shu Ching' point to the year 1110 B.C. as the first year of the Chou dynasty. The common chronology, which gives 1121 B.C. as the first year, is therefore, I believe, erroneous.

In this rapid sketch of Chinese astronomy from the time of Yao to that of Wu Wang, we have passed over many interesting incidents which it is beyond the province of the present paper to touch upon. We should like to have dwelt on the long and glorious reign of Yao, the ideal ruler, whom the best of Chinese emperors in all succeeding dynasties have taken as their model; of Yü Wang, his unwearied activity on behalf of the people he ruled over, his difficulties with the inundations, and his final success; of T'ang the Successful, and Wu Wang, who freed their country from the tyrant's yoke. No doubt a great deal is mythical, yet there is some element of truth in the narrative. The eclipse of the Sun we have just investigated is mentioned in the 'Tso Chuen,' and cannot therefore be an after calculation of later Chinese astronomers, so that I believe the astronomical references in the 'Shu Ching' belong to a very remote period. It is interesting to compare the date of this eclipse with that of eclipses mentioned in the history of other nations. The oldest such eclipse is that called after Thales, who is said to have predicted it. The Medes and Lydians were engaged in battle, when the day suddenly became night and put an end to the combat. Newcomb has fixed the year 584 B.C. as the date of this eclipse, and finds that the Sun set on the combatants $\frac{9}{10}$ths eclipsed. Other eclipses mentioned are all subsequent to this date, so that the Chinese have the honour of recording the oldest eclipse of the Sun and also the oldest of the Moon.

Astronomical references, however, in Chinese history are exceedingly uninteresting in themselves. In vain do we look for an account of the emotions of fear and admiration that the grand phenomena of nature naturally excite. An eclipse of the Sun is simply recorded without any reference to the sublimity of the spectacle, or to the awe of the beholders, as they saw the orb of day disappear in mid heavens.

The same remarks apply to the record of other remarkable phenomena, as falling stars, comets, &c., and the unsympathetic and listless way they are recorded detracts greatly from the interest of the narrative. We leave off this sketch at a period, perhaps the most interesting and brightest in Chinese history. It was at this period that Chou Kung lived, the first great Chinese astronomer and mathematician. He discovered the properties of the right-angled triangle, and made so accurate observations on the length of the shadow at different times of the year as to give a very close approximation to the obliquity of the ecliptic. He even tried to solve the problem of the Sun's distance, but as he regarded the earth as flat, his method was entirely erroneous. Finally we leave off at a period centuries before the astronomical records of other nations begin.

S. M. Russell.

---

## *Selenographical Notes.*

**Pitatus.**—Most observers of this fine but extremely abnormal ormation are aware that it must be scrutinized under many ifferent conditions of sunlight before the very curious details included by its irregular circumvallation can be duly appreciated. Among the most remarkable of these are the clefts, lettered ξ and in Neison's Map 14, which form apparent chords to the curvaure of the north-west and north-east walls respectively. It ppears at first sight somewhat strange that Mädler seems to have verlooked both these objects, not a trace of either being shown in is chart, though his representation both of Pitatus and its companion Hesiodus exhibits with these exceptions all the principal features in the neighbourhood of the rampart. Schmidt, likewise, though drawing $\phi$ as a coarse valley, has nothing on the site of the ther cleft. The most feasible explanation of these omissions lies in the fact that until the floor of Pitatus is nearly fully illuminated, both the rills are masked by shadow, ξ by the shadow of the northwest wall under morning light, and $\phi$ by that of a long mound running roughly parallel to the north-eastern border.

Between 6$^h$ and 6$^h$ 30$^m$, on October 27 this year, I was favoured with an exceptionally excellent view of both the clefts, the morning terminator touching the western flanks of Capuanus and Mercator. The rill $\phi$, on the north-east side of the floor, appeared to pass through the long mound, just mentioned, like a railway cutting traversing a hill, seen from above; reminding one of a similar appearance at the northern end of the great cleft east of Birt. The gradual widening of the cleft due to the greater depth of the cutting as it approaches the loftiest part of the spindle-shaped mound and its contraction at either end were especially obvious. Schmidt carries this cleft $\phi$ much farther in a westerly direction than Neison. On October 27, I was able to trace it as a very delicate object still farther, viz. up to the north-eastern side of a small shallow circular depression lying on the site of the wrecked border (not shown either by Schmidt or Neison, but situated a few miles north-east of the prominent crater G). In fact, at times of best definition I felt almost certain that it actually joins the other rill $\xi$ near the northern extremity of the latter. The greater part of the western section of this cleft after it emerges from the long mound is slightly but very distinctly curved,—bending towards the south. The eastern end was traced up to a gap on the border common to Pitatus and Hesidus, bounded on either side by two small but lofty mountains. Passing between these, it apparently joins the narrow pass which connects the interiors of the two formations. The cleft $\xi$ appears to be perfectly straight, and is traceable from a small crater adjoining the northern side of the large triangular depression $g$ on the west wall over the north-western side of the floor, grazing the crater G on the east and the small circular depression, mentioned above, on the west, till it thins out and disappears at a point beyond the site of the ruined wall.

Schmidt's short crater-row, forming a chord to the south-western border, has all the appearance of a cleft under low magnification, and is an easy object, especially under evening illumination. On February 16, 1883, 7h to 8h 30m, I detected what would seem to be straight narrow valley extending from near the western end of to the west of the central mountain. It has been noted on two three subsequent occasions as an extremely delicate streak, somewhat duskier than the general tone of the interior. I searched for it in vain on October 27, though the conditions of illumination were practically the same and the definition very far superior.

Beaumont House, Shakespeare Road,
Bedford, 1895, Oct. 19.

T. Gwyn Elger.

---

# CORRESPONDENCE.

*To the Editors of 'The Observatory.'*

## *The Excentric Anomaly in Double-Star Calculations.*

Gentlemen,—

In 1878 I published, in the 'Astronomische Nachrichten,' tables showing approximately the values of the excentric anomaly for each degree of mean anomaly to every tenth of excentricity and *vice versâ*. Some years ago a German bookseller published a much larger and more detailed edition of these tables. I have now communicated to the 'Astronomische Nachrichten' tables showing approximately the values of the *true* anomaly and the radius vector for every degree of the mean anomaly and *vice versâ*; and it would be useful to have larger and more detailed tables printed, if a public-spirited publisher would undertake the task. I regret that I cannot assist further in the matter, as my hands are full. These tables enable the computer to altogether avoid using the excentric anomaly in double-star calculations, and thereby his work is materially lessened. It is to be regretted that this improvement was not effected when the larger tables were printed. It ought to have been done then. It would be even possible to construct a large diagram, projecting points by aid of the true anomaly and radius vector corresponding to different values of the mean anomaly and the excentricity, and drawing curves through the points corresponding to the same value of the mean anomaly and marking the value of the excentricity at points along these curves. Points corresponding to other values of the mean anomaly and excentricity could then be interpolated and read off with the projector.

Yours faithfully,
Hongkong Observatory, 1895, Oct. 8. W. DOBERCK.

### *Supposed Early Transits of Mercury.*

GENTLEMEN,—

In your number for May 1892 there is a letter from Mr. Prince calling attention to a statement by Lycosthenes that the planet Mercury had been seen like a black spot on the Sun in the year 1278. In the following month he pointed out that this spot could not have been the planet, to see which in that position would have required a telescope, and Mr. Johnson referred to the fact that the year in question was not one of a transit of Mercury. Tycho Brahé, in his 'Historia Cœlestis,' quotes the statements of Lycosthenes that phenomena of this kind occurred in A.D. 778, 807, and 1278, but the last is evidently only a repetition of the first, for *both* are stated to have taken place near the time when Charlemagne lost part of his army by an attack of the Gascons in the Pyrenees, after his victorious expedition into Spain in 778.

I have thought it worth while to refer to this lest anyone should suppose that a large spot was seen on the Sun in 1278, as there probably was in 778 and certainly in 807, when the supposed Mercury is stated to have been so situated during eight days. Tycho points out that the planet at the time "longè à Sole abest."

It is not without interest to point out that A.D. 807 was near the epoch of a sun-spot maximum, being a little after the ninety-eighth period before the last maximum in 1893.

Yours faithfully,
Blackheath, 1895, Oct. 26. W. T. LYNN.

## *The New Star in Carina.*

Gentlemen,—

As announced in Circular No. 1 of the Harvard College Observatory, a new star has appeared in Carina. Its spectrum is practically identical with that of Nova Aurigæ and Nova Normæ. In 'Astronomy and Astro-Physics,' 1894, p. 201, I called attention to the improbability of two successive collisions between stars, occurring nearly in the line of sight, in both cases a bright- and a dark-line star being involved, and in each case the bright-line star being the one to recede from us. The same remarks apply to the theory of the collision of a star and a nebula. As a substitute I offered an explosion hypothesis, in which a dark sun suddenly gave out in all directions large quantities of hydrogen in an incandescent state. This would of course merely produce a spectrum with bright lines. But if the expulsion of hydrogen continued, the outer layers of gas would cool, producing absorption lines in the spectrum of the approaching hydrogen, but still leaving the spectrum lines of the receding hydrogen bright. Finally, when the expulsion ceased, we should find a heated spherical mass of gas, similar to a planetary nebula. It was shown that the velocities which were observed in the cases of these two *novæ* were less than 50 per cent. greater than what had occasionally been observed in our own Sun. The discovery of this third *nova*, with a spectrum identical with that of the two others, increases many times the improbability of the collision theories, and thereby strengthens the explosion hypothesis. If the latter is correct, we must look upon the phenomena presented by a *nova* not as indicating the birth of a new star, but rather as a cataclysm testifying to the death and final disrupture of an old one.

Yours truly,

William H. Pickering.

Harvard College Observatory,
1895, Nov. 5.

## *Distances of some Small Planets.*

Gentlemen,—

I see my name very kindly mentioned on p. 395 of your November issue, in connection with a statement as to the nearest perihelion distances of minor planets. May I be allowed to add to that statement by drawing attention to what seems to be a misprint in the 'Annuaire du Bureau des Longitudes' for 1895? Planet No. 380 is stated upon p. 292 to have a mean distance 4·67722, and is quoted in Général Parmentier's interesting article and diagram, published in the 'Bulletin Mensuel de la Société Astronomique de France' for March last, as being the minor planet whose mean distance is the greatest of any then discovered. It would, however, appear from the periodic time, which is given as 1600 days, that 4·67722 is a misprint for 2·67722, and this is confirmed by the value of log $a = 0·427685$ in the 'Berliner Jahrbuch.' I believe that the greatest mean distance is that of

Thule, No. 279, which is 4·262060; but the greatest aphelion distance is that of No. 361, viz. 4·771184, while the aphelion distance of Thule is only 4·619144. The mean distance of No. 361 is, however, only 3·96197, but the orbit has the large eccentricity of ·204412. It is interesting to compare these values with the perihelion distance of Jupiter, 4·951755. The difference in the case of the aphelion of No. 361 is only ·18, or very nearly 16¾ millions of miles. That minor planet's aphelion and Jupiter's perihelion, however, differ by about 97° in longitude.

Yours faithfully,
E. LEDGER.

Barham Rectory, Ipswich,
1895, Nov. 18.

## OBSERVATORIES.

THESE notes, extracted from the 'Vierteljahrschrift der Astronomische Gesellschaft,' are intended to give, in brief, a sketch of the chief work at these observatories during the year 1894. Many are attached to universities, and at these much time is occupied in instruction.

BAMBERG. *Ernst Hartwig.*—Bad observing weather, only 122 clear nights. Diameters of Sun on 26 days with heliometer; diameters of Venus and Mars; observations of variable stars. The great refractor was used, as in former years, for spectroscopic, photometric, and photographic work. Meteorology.

BASEL. *Riggenbach-Burckhardt.*—This is almost exclusively a meteorological observatory. Watches have been tested and work done in connection with the Geodetic Survey.

BERLIN. *W. Foerster.*—No important changes have been made either in the staff or instruments. Herr Battermann, observing with the transit-circle, secured 3690 transits and 3076 declinations.

Dr. Knorre has continued his observations of double stars with the Wellmann double-image micrometer attached to the 9-inch refractor; he has made during the year 399 distance measures and 415 measures of position.

DRESDEN. *Dr. B. von Engelhardt.*—Observations of stars whose proper motion is at least 0″·1; observations of Bradley stars. Positions of Comets 1894 (I.) Denning on four nights, 1894 (II.) Gale on two nights. The results were published in the 'Astronomische Nachrichten.' All these were made with a 12-inch Grubb refractor.

DUSSELDORF. *R. Luther.*—Observations and ephemerides of small planets. Herr Luther observes them with a ring-micrometer.

GENEVA. *R. Gautier.*—The Plantamour 10-inch refractor has been used for photography, observations of comet 1893 (IV.) Brooks, 1894 (I.) Denning. The surface of Mars has been studied on many occasions, but, as formerly, "sans résultats intéressants." Mars has always been difficult to observe with this instrument, while it gives excellent images of Jupiter and Saturn. 494 watches were tested during the year. Meteorology.

[To be continued.]

## PUBLICATIONS.

A Memoir on some Greenwich Star-Catalogues.—No. 30 of the 'Vierteljahrschrift der Astronomische Gesellschaft' contains an interesting article by Dr. Oertel on the Greenwich Ten-Year (1880) and Five-Year (1890) Catalogues. A very good description is given of the Greenwich Transit Circle and of the conditions and methods of observation, as well as necessary particulars about the Catalogues, and references are made to, and extracts taken from, several recent papers on subjects connected with the Greenwich Meridian Observations, the R—D discordance, and the observation of the collimators through the cube of the instrument.

The memoir, as we have said, is interesting and evidently the result of much careful work, but we think that some of the deductions call for comment. From consideration of Prof. Turner and Mr. Thackeray's paper on the R—D discordance, in which a series of observations is given, showing that the discordance between the reflexion and direct observation of zenith-distance is affected by the order of the observations, Dr. Oertel thinks that it would have been better not to have applied a correction for the R—D discordance to the *direct* observations. This conclusion seems to us quite unjustifiable. These observations demonstrate the instrumental nature of the discordance in question, but cannot be said to show that the direct observation requires correction any less than the one by reflexion.

In a later part of his paper Dr. Oertel attempts to obtain corrections from the differences between the North Polar distances observed above and below Pole to obtain a correction to the colatitude, to the refractions, and for flexure. He finds, however, on forming normal equations, that they are unsuitable to determine these three corrections, and therefore treats the differences in question as giving corrections only to the colatitude and the refraction, and derives corrections $-0''\cdot25$ to the colatitude and $-0''\cdot25$ to the refraction constant. But as the equations he uses for this determination, on division by the coefficients of $x$, become

$$\left.\begin{aligned} x+2\cdot37\,t &= -0''\cdot102 \\ \text{and } x+2\cdot80\,t &= -0\,\cdot250 \end{aligned}\right\}$$

they are evidently not very suitable for the purpose, and several considerations are necessary before such corrections can be regarded as final.

Some criticism of Dr. Oertel's remarks on the accuracy of the Catalogues must be made. He compares the probable error of a zenith-distance at Greenwich (as found by Mr. Stone, M. N. vol. xxix. p. 324) with that of several other catalogues, and finding that it is no smaller than the probable error in the zone catalogues of the 'Astronomische Gesellschaft,' he concludes that the Greenwich Polar distances are inferior in accuracy to those of the best catalogues. The case in point offers a very good example of the fallacy of relying too much on comparison of observations *inter se*. The first two zone-catalogues mentioned by Dr. Oertel are those at Helsingfors and Christiania. Their probable errors for one observation are given as ±0″·51 and ±0″·54, and as they have a zone of 10′ in common, the places of 357 stars common to the catalogues have been compared by the writer, and a systematic difference of −0″·47 is found between them, and, allowing for this, a mean discordance of ±0″·96. Here we have a case of two catalogues based on the same system of fundamental stars having a large systematic difference, which seems *a priori* very unlikely, and apart from this, with a mean discordance of ±0″·96, when, as there are, on the average, more than two observations of each star in each catalogue, we should have expected one of not more than ±0″·50. The only conclusion we can come to is that the probable error is not a sufficient criterion of the accuracy of these catalogues. In the Greenwich Observations the traditional policy has been to vary the conditions of the observations as much as possible, to reject practically no observations, and to reduce the observations in a strictly unvarying manner. The principle has been to eliminate systematic error as far as possible, trusting that accidental error would be eliminated by multiplication of observations. By a different method of adopting zenith-points it is quite likely that a greater accordance of results *inter se* could be obtained, but there would be danger of introducing systematic error. The success which has attended the Greenwich methods is strikingly shown in Prof. Safford's paper in the 'Monthly Notices' (vol. lv. p. 495), by the comparison of the Greenwich Ten- and Five-Year with the Pulkowa 1885 places and with those of the 'Berliner Jahrbuch.' From this comparison he finds the systematic error of the Greenwich places to be very small. F. W. D.

GREAT ASTRONOMERS.—It has sometimes seemed to us that Sir Robert Ball's works could hardly claim to be of interest to those who come within the category of astronomers. This remark is not made with the intention of depreciating this prolific author's books, for we believe that they are written for popular instruction and that they admirably fulfil their purpose. We are sure, however, that the latest book * by the Cambridge professor will be read with interest both by astronomer and layman. This contains brief biographies, written with a light touch, of eighteen eminent men, from Ptolemy to Adams. It need scarcely be said that the facts here given do not see the light for the first time, for the author has drawn on such books as Dr. Dreyer's in the case of Tycho Brahé, and on the obituary notices of the Royal Astronomical Society for the lives of men of more recent date; but it is useful to have such facts collected in one book, and, moreover, there is a good deal, we speak specially with reference to the Irishmen, Lord Rosse, Brinkley, and Hamilton, which Prof. Ball evidently adds from his own personal store. The book is illustrated, not with astronomical diagrams, but with pictures of persons and places, and forms altogether a pleasant addition to the light literature of astronomy.

---

* 'Great Astronomers,' by Sir R. S. Ball, D.Sc., LL.D., F.R.S. Isbister & Co. London, 1895. 7*s*. 6*d*.

---

## NOTES.

Comet Notes.—A bright comet was discovered by Perrine at the Lick Observatory on November 17. Prof. Campbell has deduced the following elements from observations on Nov. 17, 18, 19; they are, of course, still uncertain:—

Perihelion Passage, 1895 Dec. 18ᵈ·41 G.M.T.

| | | |
|---|---|---|
| $\pi$ ........ | 233° 50′ | 1895·0. |
| ☊ ........ | 320 49 | |
| $i$ ........ | 141 25 | |
| $q$ ........ | 0·1914 | |

From these elements we have computed the following ephemeris for December (Greenwich midnight):—

| | R.A. h m s | S. Dec. ° ′ | Brightness (Nov. 17 = unity). |
|---|---|---|---|
| Dec. 2 ........ | 14 34 54 | 9 45 | 6·44 |
| 6 ........ | 15 1 36 | 14 36 | 12·7 |
| 10 ........ | 15 44 20 | 20 38 | 28·1 |
| 14 ........ | 16 53 28 | 26 7 | 63·6 |
| 18 ........ | 18 15 52 | 27 20 | 83·0 |
| 22 ........ | 18 58 56 | 24 20 | 33·7 |
| 26 ........ | 19 13 52 | 21 6 | 12·3 |
| 30 ........ | 19 20 36 | 18 25 | 5·68 |

Dr. Lamp observed the comet at Kiel on Nov. 18, and describes it as fairly bright, but not visible to the naked eye, round, with central condensation and a tail.

It will be seen that, if the above elements are correct, the comet will be very brilliant in the middle of December, and may possibly be visible in daylight.

We have just received the following elements and ephemeris from Dr. Lamp, which it will be seen differ considerably from those given above:—

T = 1895 Dec. $24^{\mathrm{d}}\cdot011$ Berlin M.T.

| | |
|---|---|
| π ........ | 286° 22′ |
| ☊ ........ | 346 37 |
| *i* ........ | 110 42 |
| *q* ........ | 0·1281 |

Ephemeris for Berlin Midnight.

| | R.A.<br>h m s | S. Dec.<br>° ′ | Brightness. |
|---|---|---|---|
| Nov. 29 ...... | 14 17 40 | 6 2 | 2·6 |
| Dec. 3 ...... | 14 33 4 | 9 28 | 4·1 |
| 7 ...... | 14 52 37 | 13 37 | 6·8 |

Another bright comet was discovered by Brooks on Nov. 21. Dr. Leuschner has deduced the following elements and ephemeris for Greenwich midnight) :—

T = 1895 Oct. $21^{\mathrm{d}}\cdot21$ G.M.T.

| | |
|---|---|
| π ........ | 22° 0′ |
| ☊ ........ | 83 1 |
| *i* ........ | 76 43 |
| *q* ........ | 0·8459 |

| | R.A.<br>h m s | N. Dec.<br>° ′ |
|---|---|---|
| Nov. 29 ...... | 9 21 42 | 5 31 |
| Dec. 3 ...... | 8 56 30 | 23 12 |
| 7 ...... | 8 19 30 | 41 29 |

Brightness diminishing pretty rapidly.

M. Schulhof has computed a new orbit of Swift's Comet 895 II.), making use of 48 observations extending over two months; the following are the elements he arrives at :—

T = 1895 Aug. $20^{\mathrm{d}}\cdot8273$ Paris M.T.

| | | | |
|---|---|---|---|
| π ........ | 338° 4′ 16″ | *e* ........ | 0·65155 |
| ☊ ........ | 170 18 8 | log *a* .... | 0·571004 |
| *i* ........ | 3 0 15 | Period .... | $7^{\mathrm{y}}\cdot186 \pm 15^{\mathrm{d}}$ |

These elements show a close resemblance with those of Lexell's Comet, and M. Schulhof concludes that the two bodies may not improbably be identical, but that, if not, they had a common origin. The above orbit approaches within 0·007 of that of Mars in longitude 15°, and within 0·08 of that of Jupiter in longitude 180°. There was, in fact, a close approach to the latter planet in March 886. The comet will not be again as favourably placed as it was at discovery till its fifth return in 1931.

M. Schulhof gives the following ephemeris for Paris Midnight :—

| | R.A.<br>h m s | N. Dec.<br>° ′ | | R.A.<br>h m s | N. Dec.<br>° ′ |
|---|---|---|---|---|---|
| Dec. 5 .... | 1 46 40 | 5 51 | Dec. 20.... | 2 0 53 | 7 38 |
| 10 .... | 1 51 2 | 6 25 | 25.... | 2 6 19 | 8 16 |
| 15 .... | 1 55 47 | 7 0 | | | |

Ast. Nach. 3316 contains observations of Faye's Comet made with the 30-inch refractor at the Nice Observatory from Sept. 2 to Oct. 20. It is described as a faint round nebulosity about 20 in diameter.

It has likewise been under observation at Washington, and with the 26-inch refractor of the Leander McCormick Observatory ; is, however, described as extremely faint and small.

We continue the ephemeris:—

| | R.A. | | | S. Dec. | | | R.A. | | | S. De | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | h | m | s | ° | ′ | | h | m | s | ° | |
| Dec. 4.... | 22 | 5 | 5 | 5 | 34 | Dec. 20.... | 22 | 34 | 18 | 4 | |
| 8.... | 22 | 11 | 57 | 5 | 21 | 24.... | 22 | 42 | 24 | 4 | |
| 12.... | 22 | 19 | 1 | 5 | 6 | 28.... | 22 | 50 | 51 | 3 | |
| 16.... | 22 | 26 | 32 | 4 | 47 | | | | | | |

A. C. D. C.

---

Minor Planet Notes.—Prof. Barnard has published in 'Popular Astronomy' for November his measures of the diameter of Juno, his adopted values for the diameters of the four principal asteroids being as follows:—Ceres 485 miles, Pallas 304, Juno 118, Vesta 243. He has also computed their albedos, taking the albedo of Mars as unity, with the following results:—Ceres 0·67, Pallas 0·88, Juno 1·67, Vesta 2·77. Müller's values for the albedos of the major planets (taking Mars as unity) are:—Mercury 0·64, Venus 3·44, Jupiter 2·79, Saturn 3·28, Uranus 2·73, Neptune 2·36.

The planet CA, discovered by Charlois on July 23, proves to be identical with (336) Lacadiera. An error of 1′ has been detected in one of the observations of this planet in 1892, which considerably modifies the elements. BZ, CB, discovered by Charlois on July 23 and Aug. 22, have received the permanent numbers 405, 406 respectively.

(401) Ottilia has a period almost exactly half that of Jupiter, which will make the theory of its motion very interesting.

A. C. D. C.

---

The Spectrum of Altair.—M. Deslandres has recently announced (Comptes Rendus, Vol. cxxi. No. 19, p. 629) some important results from his photographs of the spectrum of this star, already interesting to us from its showing a number of the metallic lines broad, as well as those of hydrogen.

The first result which M. Deslandres records is the more important. It consists in the discovery of a little double bright line in the centre not only of the broad hydrogen lines, but also sometimes in those of calcium and iron. This discovery would range Altair alongside our own Sun, and be the indication to us of just such a chromospheric and faculous region in that star as the spectroheliograph has shown us in the Sun. We could, indeed, have had no doubt previously that other stars resembled our Sun in the possession of such a region, but M. Deslandres' announcement would come to us as the direct demonstration of it.

The second result M. Deslandres announces is, we fear, somewhat doubtful. His measures of the motion of Altair in the line of sight show considerable irregularities, greater, he considers, than can be ascribed to the errors of observation. He accounts for these irregularities by supposing Altair to be a triple star, and hence to have a double orbital motion, of periods of 43 and 5 days respectively, periods which are, however, slightly variable. It need scarcely be said that observations should be very numerous and precise to warrant such a deduction being regarded as more than a mere contrivance; and those of M. Deslandres scarcely seem to have the requisite precision, and are certainly not sufficiently numerous nor sufficiently sustained to carry conviction. At best the announcement must be looked upon as premature.

HARVARD COLLEGE CIRCULARS.—The authorities of Harvard College Observatory have felt for some time past that it would be expedient to have some means of announcing promptly the results of their work, which often take the form of discoveries of new stars or of variability of stars. It is proposed therefore to issue as required a series of circulars to make announcements of this kind or such as will be of interest to astronomers. The issue, we understand, will be confined chiefly to the editors of publications, by which means it is hoped the news will be conveyed to the astronomical public. We shall be glad to help in this scheme.

A NEW STAR IN CARINA.—Harvard College Circular No. 1 announces that Mrs. Fleming has discovered, from examination of the photographs of star-spectra taken at Arequipa, that a new star appeared in the constellation Carina in the spring of 1895. "A photograph taken on 1895, April 14, with an exposure of 60 minutes, shows a peculiar spectrum on which the hydrogen lines $H\beta$, $H\gamma$, $H\delta$, $H\epsilon$, and $H\zeta$ are bright, and the last four of these are accompanied by dark lines of slightly shorter wave-length. A conspicuous dark line also appears about midway between $H\gamma$ and $H\delta$. A comparison of the spectrum of this star with that of Nova Aurigæ and Nova Normæ * shows that all three closely resemble each other and are apparently identical in their essential features. Another photograph taken on June 15, with an exposure of 60 minutes, shows a change in the spectrum of this object. The hydrogen lines $H\beta$, $H\gamma$, and $H\delta$ are still bright, though the continuous spectrum is very faint. Another line, whose wave-length is about 4700, is here as bright as the hydrogen lines. On the photograph taken on April 14 it is barely visible."

Naturally, all available astro-photographs were then examined to detect, if possible, traces of this star. On 62 plates taken between 1889, May 17, and 1895, March 5, no trace of the star is visible, although on some of them stars of the 14th mag. are

---

* Prof. W. H. Pickering refers to the fact in a letter on p. 436 of this number.

clearly seen. On nine plates taken between 1895, April 8 and July 1, the star appears and its photographic magnitude diminishes during that time from the 8th to the 11th mag. The star precedes A.G.C. 15269 (photometric mag. 5·47) by $0^{m}{\cdot}5$ and is $0'{\cdot}7$ north. Its approximate position for 1900 is therefore R.A. $11^{h}\ 3^{m}{\cdot}9$, Dec. 61° 24′ S. Two stars of the 11th mag. are near the Nova.

Central European Time.—The following is an extract from a South-American newspaper:—

"In Switzerland and on the Rhine the recent adoption of the Central European mean time has produced a singular effect, viz. a marked diminution in the receipts of the gas companies. The difference between the new time reckoning and the local time varies from half an hour to an hour, and people have come to regulate their habits in conformity with the alteration of the time.

"Here in Buenos Ayres it is just the contrary: our local time is nearly half an hour late, and consequently everybody gets up and goes to bed half an hour later, thus enabling the gas companies to report a considerable increase in their receipts."

## From an Oxford Note-Book.

A committee of the British Association has lately obtained a most valuable result. In his able address, delivered last year at Oxford, Professor Rücker dwelt at some length on the 'discrepancies between the so-called standard" instruments used for measuring Declination and Horizontal Force—to which Dr. Van Rijckevorsel had first called attention,—and he suggested a 'full primary comparison between the standard magnetic instruments in use at our different observatories.' The matter was indeed urgent, for "there was little doubt that the (standard) instruments at present used for measuring Declination and Horizontal Force are affected with errors far greater than the error of observation." Upon this representation the Association appointed a small Committee to investigate the matter, with most satisfactory results; for, although only an interim report has been presented, it is tolerably clear that the source of error has been discovered. This discovery is entirely due to the labours of Professor Rücker and Mr. Watson, who "have carefully compared three Kew-pattern magnetometers in order to investigate the causes of the discrepancies between the measurements of declination made with them; and found that if the greatest care be taken in the manufacture of the wooden box and the metallic adjuncts which are close to the magnet, the discrepancies disappear. In other words, the cause of the difficulty, in these three instruments at all events, is not the metal base, but the much smaller masses of metal which are nearer to the magnet. The three magnetometers are now in good accord." Comment is superfluous.

IN the March number of this magazine I gave a mechanical illustration of the adjustment by least squares for two overlapping stellar photographs. The measured positions of corresponding stars were to be connected by short elastic strings, the various tensions of which would bring one plate into a position of stable equilibrium relatively to the other—corresponding to the least square solution. Professor Newcomb has kindly drawn my attention to two papers in vol. xxxiii. of the 'Monthly Notices' (1872-3), wherein somewhat similar mechanical representations are given. In the first paper, for instance, this problem is considered: Given the observed right ascensions of a star at several epochs, to find the most probable R.A. at any other epoch. And the following rule is given:—Plot the observed values of the quantity sought on a plane where the abscissæ represent the times, and the ordinates the values observed. Let a straight rigid rod be attracted by each of these points with a force proportional to the weight of the corresponding observation multiplied by the distance of the point from the rod; then the position of equilibrium of the rod will be that corresponding to the most probable course of the variable quantity, the perpendicular distances of the point from the rod representing outstanding errors of observation. Several other consequences are also pointed out, as, for instance, to find the relative influence of the various observations in determining the computed value of the variable quantity at any epoch, apply a pressure to the rod at the point corresponding to this epoch, then observations at the point round which the rod turns in consequence of this pressure will be without influence, and at any other point will have an influence proportional to the distance of that point rom this centre of rotation, whether before or after.

---

THE general theory of least squares is at the present time the ubject of much discussion outside astronomy and physics—specially in the biological world. Prof Karl Pearson's brilliant Contributions to the Mathematical Theory of Evolution" in the *'hil. Trans.* are well worthy of careful study. He has succeeded n solving a problem which has long baffled theoretical statisticians —that of breaking up into normal groups statistics relating to ifferent types—such as the measurements of stature in a province ontaining two heterogeneous races. I was scarcely prepared, owever, to find the following ingenious little quip in a paper with e sober title "On some recent Contributions to the Theory of tatistics"—a paper by Prof. Edgeworth discussing Prof. Pearson's searches, and printed in the Journal of the Royal Statistical ociety (September 1895). The particular example under discuson is the frequency of divorces, and the author says "But there no certainty about the cause of these observations, no science, s there is in the case of the general law of error. Perhaps the atistics of divorce do not form even a particular law of error, do ot result from even a few co-ordinate causes, but from one dominant cause. *In rerum naturâ* there are other laws besides the law of error. The *law of cooling* is different from the law of error in physics; and why not also in the moral world?"

As many readers of this journal may not have the opportunity of referring to the Journal of the Royal Statistical Society, I am tempted to quote another passage from the same paper, which will bear a wider application than it has in the particular case. Professor Edgeworth has been criticizing somewhat adversely Professor Pearson's "Generalized probability Curve," but admits in its favour some weighty considerations, of which one is "the wonderfully close fit of Professor Pearson's formulæ to the facts. It is a nice question," he proceeds, "what weight should be attached to this correspondence by one who does not perceive any theoretical reason for the formulæ." A similar case would be Carrington's formula for the motion of Sun-spots involving the factor $\sin^{\frac{7}{4}}$ (latitude) for which no theoretical reason can be perceived, though the formula fits the facts. Professor Edgeworth proceeds to give the following striking analogy:—"The philologist does not accept the school-boy's derivation of *virgo* from *vir*, a man, and *ago*, I lead, although it fits closely the word in its old form *virago*. It might be hard to define the reason for not accepting the derivation. There is a sort of sixth sense acquired by experience. The matter is one on which authority ought to count."

ONE of the recently-discovered poets seems to take full advantage of his license. Mr. John Davidson contributes to 'Phil May's Winter Annual' a "Ballad of an Artist's Wife," in which occur the following stanzas:—

"The Sun began to smoke and flare
Like a spent lamp about to die;
The dusky Moon tarnished the air;
The planets withered in the sky.

"Earth reeled and lurched upon her road;
Tigers were cowed, and wolves grew tame;
Seas shrank, and rivers backward flowed,
And mountain-ranges burst in flame."

This is pretty good minor poetry, though but indifferent astronomy; but the next verse seems to me to put a strain upon our imagination which it will scarcely bear:—

"The artist's wife, a soul devout,
To all these things gave little heed;
For though the Sun was going out
There still were little mouths to feed."

Surely it is difficult to accept this statement without feeling that the good lady must have been rather—well, unobservant!

# INDEX TO VOL. XVIII.

Page

hromatic Objectives, Cooke &
Son's ........................ 65
ams (Prof. J. C.), The Memorial
o ............................ 244
ams's (Prof. J. C.) Determina-
ion of the Masses of Jupiter's
Satellites (Sampson) ............ 293
— MSS. ........................ 68
justment of a Photographic
Equatorial, On the .............. 252
gol ........................... 229
air. Deslandres on the Spec-
rum of ........................ 442
trographic Chart, Bulletin of the
Permanent Committee ........... 279
tronomy in Australia ...... 174, 175
tronomical Association, British,
Meetings of the ... 45, 79, 103, 150,
188, 225, 263, 421
— Society, Meetings of the Royal 35,
71, 107, 139, 179, 215, 255, 411
— —— of Belgium ............... 250
— —— of Wales ................. 210
— —— Club ..................... 103
— Allusions in Literature ...... 177,
213, 214, 253, 254, 289,
290, 322, 350, 407, 446
— Conference ................... 134
— Journal Prizes ........... 133, 318
Astronomie' .................... 66
stro-Physical Journal,' Estab-
lishment of the .................. 66
rora Borealis, The ............. 174

*ckhouse, T. W.*, Variable Orange
Stars ..................... 94, 165
ll's 'Great Astronomers' ......... 439
itish Association, Extract from
President's Address ............. 358
*wn, Miss E.*, Variable Orange
Stars .................... 120, 200
reau des Longitudes, Annuaire
du ............................ 124

*mpbell, W. W.*, On selecting
suitable nights for observing
Planetary Spectra ........... 50, 121
ssini and the Principal Division
in Saturn's Ring (Lynn) ......... 118

Page

Cayley, Prof. Arthur ............. 112
Chinese Astronomy (Russell). 323, 355
430
Chronology and Eclipses (Lynn). 92,
197
—— —— (Stockwell) ......... 57, 161
*Clerke, Miss A. M.*, Some anoma-
lous Sidereal Spectra ........... 193
Clerke's (Miss) 'The Herschels and
Modern Astronomy' ............. 401
Cœlostat, The ...... 301, 319, 348, 349
Comet of 1525, The alleged (Lynn) 120
—— ——, —— (Dreyer) ......... 164
—— ——, —— (Prince) ......... 165
—— of A.D. 945, The supposed
(Lynn) ......................... 335
——, De Vico's Periodic (1844 I.)
(Denning) ....................... 60
—— 1894 I. (Denning) ............ 199
Comets discovered by De Vico
(Lynn) ......................... 163
——, Nomenclature of .............. 105
—— Notes ... 64, 100, 126, 170, 206,
281, 313, 342, 372, 403, 440
——, Popular Notions about ...... 347
Conferences, On ................. 176
Corrections to Transit Observa-
tions, Application of ............ 209
Crossley Reflector, The .......... 210

Dante's Astronomy ........... 248, 286
*Denning, W. F.*, Comet 1894 I. ... 199
——, De Vico's Periodic Comet ... 60
——, Fireball of 1895, June 10 ... 270
——, Lyrids, The April ............ 161
——, Meteor of 1895, July 7 ...... 325
——, Meteoric Radiants near γ
Pegasi .......................... 233
——, Naked-eye Views of Mercury 273
Diffraction Phenomena, Hira-
yama's Pictures of .............. 104
*Doberck, Dr. W.*, Heis's T Radiants. 199
——, The Excentric Anomaly in
Double-Star Calculations ........ 434
——, Time-Service of the Hong-
kong Observatory ................ 297
*Doolittle, Prof. C. L.*, Latitude
Determinations .................. 90

Page

Doppler's Principle applied to Planetary Observations...... 211, 212
Double-Star Measures ............ ... 402
*Dreyer, Dr. J. E. L.*, The Alleged Comet of 1525 ........................ 164
——, The Total Solar Eclipse of A.D. 1030 ........................... 363
*Dyson, F. W.*, The Determination of Right Ascension and Declination on a Photographic Plate ... 328
——, Professor Cayley............... 112

**E**clipse of the 'Shu Ching,' The supposed Chinese (Lynn).......... 61
——, Total Solar of A.D. 1030 (Lynn) ............................... 336
—— —— —— (Dreyer)............ 363
—— —— of 1893, April 16, Lick Report of ............................ 369
——, Solar, of 1895, March 26 ... 173
——, ——, ——, Aug. 20 ......... 318
——, Total Lunar, of 1895 March 10 .............................. 172, 178
——, ——, —— (Johnson).......... 165
——, Total Solar, of 1896, Aug. 8. 378
——, —— —— (Geelmuyden) ... 199
——, ——, 1898, Jan. 21............ 251
Eclipses, Ancient Indian (Stockwell) ................................ 127
Electrical Measurement of Starlight ................................. 342
*Elger, T. G.*, Selenographical Notes ... 52, 85, 117, 157, 196, 231, 271, 305, 334, 361, 433
Elger's 'The Moon' ......... 211, 239
Examination Questions ...... 254, 290
Excentric Anomaly in Double-Star Calculations (Doberck) ........... 434

**F**igures, The use of...... 106, 376, 377
—— necessary in Reductions, On the number of (Stone, Turner) . 391, 424
Fireball of 1895, June 10 (Denning) 271
Flying Machines ..................... 321
*Frost, Prof. E. B.*, On a new method of determining Velocity of Stars in the Line of Sight ... 394

**G**ale, W. F., A magnificent Meteor 91
*Geelmuyden, H. G.*, The Total Solar Eclipse of 1896, Aug. 8............ 199
Greenwich Observatory, Building of ...................................... 289
—— ——, Visit of Shahzada, to ... 318
—— ——, Visitors to ................ 347
—— ——, Visitation Day at ...... 211

Greenwich Star-Catalogues, Oertel's Memoir on ............................ 4
Gregory's 'The Planet Earth' ... 1

**H**arvard College Circulars .......... 44
Heis's T Radiants, On (Doberck) . 19
—— —— (Monck) .................. 27
Helium ................................... 252
Hong-Kong Observatory, The Time-Service of (Doberck) ...... 297
*Huggins, Dr. W.*, On the Duplicity of the Solar line $D_3$ .............. 295

**J**ackson-Gwilt bequest, The ... 69, 212
*Johnson, S. J.*, The Total Lunar Eclipse of 1895, Mar. 10 .......... 165
——, Occultation of Regulus ...... 311
Jupiter, Periodicity of Markings on (Waugh) ........................ 311
——, —— —— (Noble) ............ 337
Jupiter's Satellites, Observations of 284

**K**ennedy's 'A few Chapters in Astronomy' ........................ 98
*Kiær, H. I.*, A Proof of the Law of Gravitation ........................ 364
Knott's Variable Star Observations 69

**L**atitude Determinations (Doolittle) ................................. 90
Latitude, Variation of ......... 114, 266
—— ——, A mechanical interpretation of ............................ 314
—— ——, Tide (Chandler) ...... 332
Law of Gravitation, A proof of the 315, 364
Least Squares, Notes on... 135, 44, 446
*Ledger, Rev. E.*, Distances of some Small Planets................ ..... 436
*Lewis, T.*, On the Dimensions of Saturn's Rings ..................... 379
——, A note on Stellar Parallax . 152
——, On the System σ Ursæ Majoris ................................. 83
Longitude of Batavia, The (Oudemans) ..................................... 36
—— of Madras, The........... 25, 33
Lunar Atlas, A.................. ..... 4
*Lynn, W. T.*, Cassini and the principal Division in Saturn's Ring 1
——, Chronology and Eclipses. 9, 1
——, Comet of 1525 ......................
——, Comets discovered by De Vico
——, Constitution of Saturn's Rings ......................................
——, Discovery of Small Planets: Perihelion Distances............ ..

Page
*T.*, Lamont's Observa- Neptune .................. 275
posed Chinese Eclipse of a Ching'...................... 61
posed Comet of A.D. 945. 335
posed Early Transits of r .......................... 435
al Solar Eclipse of 1030 . 336
ibility of the Dark Side is.......................... 362
Remarkable Comets' ...... 125
ie April (Denning) ...... 161

The Longitude of ... 250, 330
Observations, Some Disies in ...................... 444
.............................. 53
iteness of ................. 319
meter of...................... 375
inals, Optical Suggestions ison of ...................... 409
Naked-eye Views of ng) ............................ 275
posed Early Transits of .............................. 435
nsit of, on 1894, Nov. 10. 101
1895, Jan. 1................ 93
agnificent (Gale) ... ..... 91
95, July 7 (Denning) ... 325
ants, Stationary (Monck). 365
near γ Pegasi (Denning). 233
gical Society, Meetings Royal... 46, 79, 111, 151, 189, 226, 265, 423
y, Easton on the distriof Stars in the ........... 125
of. J., On the cause of the sturbance of position of ents ........................ 409
loss of his Scientific Re- ...... ........................ 408
inets, Discovery of and on Distances of (Lynn, ... ..................... 395, 436
net Notes ...... 65, 101, 127, 172, 207, 283, 314, 342, 373, 442.
*H. S.*, Heis's T Radi- ........................... 274
eid Radiant .............. 55
ionary Meteor-radiants . 365

*la, Prof. K. D.*, Nebula 15 of the New General ie ............................ 310
Almanac' for 1898 ...... 124
o. 6595 of the New Catalogue (Naegamvala). 310

Page
Nebulæ, Dr. Dreyer, On Micrometric observations of........... 70, 103
——, ——, Catalogue of ........... 368
Nepture, The diameter of........... 208
——, Lamont's observations of (Lynn)................................ 277
Newcomb's 'Fundamental Constants of Astronomy' ........... 202
—— New Planetary Tables ... 80, 135
*Noble, Capt. W.*, Periodicity of Jupiter's Markings..................... 337
——, Variable Orange Stars......... 201
*Nyrén, M.*, The Pulkova Standard Catalogue for 1885.................. 58

OBITUARY:—
  Ball, Dr. V......................... 289
  Brorsen, Th. ...................... 211
  Cayley, Prof. A............. 103, 112
  Cockle, Sir J....................... 103
  Denza, Francesco ............... 47
  Dunkin, R........................ 174
  Fabritius, Dr. W. ........... .... 347
  Kirkwood, Prof. D. ...... 318, 344
  Maclear, G. W. H. ............ 309
  Peters, C. F. W.................. 47
  Pihl, Dr. O. A. L................ 309
  Ranyard, A. Cowper.. ......... 48
  Rebeur-Paschwitz, E. von ... 406
  Spörer, Dr. F. W. G.... ........ 307
  Tietjen, Dr. F. .................... 308
  Trouvelot, M. L............... ... 245
OBSERVATORIES (publications in italic figures):—
  Albany ........................... 95
  Bamberg.......... ............... 437
  Basel ............................. 437
  Berlin.............................. 437
  Brussels .......................... *125*
  Cape ....................... *166*, 396
  Dresden .......................... 437
  Dusseldorf........................ 437
  Geneva ........................... *125*
  Greenwich ........................ 276
  Hamburg ......................... 239
  Harvard ..................... 96, *168*
  Hong Kong ...................... 368
  Liverpool ........................ 279
  Madras ........................... 312
  Melbourne ........................ 397
  Meudon ........................... 313
  Natal .............................. 95
  Nice................................. *341*
  Oxford (University) ........... 277
  Paris ....................... *169*, 236
  Pennsylvania (Flower)......... 407
  Perth (Australia) ............... 319
  Poona College of Science ...... 339
  Potsdam.......................... *341*

Page

OBSERVATORIES (*cont.*):—
  Rome (Vatican) .................... 63
  Rugby.............................. 238
  Stockholm ......................... 368
  Stonyhurst ........................ 202
  Windsor (N.S.W.), Mr. Tebbutt's ....................... 313
  Wolsingham ........................ 121
  Yale............................... 338
Occultation of B.A.C. 6127, Daylight (Tebbutt) ...................... 396
—— of Regulus (Johnson) ......... 311
*Orbinsky, A.*, A new method of determining Velocity of Stars in Line of Sight.................. 303, 393

**P**arallax, Stellar, and a list of Mean Parallaxes (Lewis).................. 152
Parker's 'Elements of Astronomy' 62
Perseid Radiant, The (Monck) ... 55
PERSONAL NOTES:—
  Barnard ..................... 318, 375
  Bredichin ......................... 103
  Christie .......................... 134
  Doolittle.......................... 375
  Ellery ............................ 318
  Forsyth ........................... 132
  Gould ............................. 378
  Hinks ............................. 174
  Lewitzky............................ 68
  McClean ........................... 250
  Power ............................. 174
  Struve, H. ........................ 311
  Struve, L. ......................... 68
  Struve, O. ........................ 137
Phobos, Probable revolution of the Orbit of .......................... 129
Photographs, Stellar, Rutherfurd's, Remarks on ..................... 287
——, ——, On the Duration of life of.................................. 288
*Pickering, Prof. W. H.*, The New Star in Carina .................... 436
Planetary Spectra, on selecting suitable nights for observing (Campbell).......................... 50
—— Tables, Newcomb's new... 86, 135
Pouillet on Heat from Stars ...... 253
*Prince, C. L.*, The alleged Comet of 1525 .............................. 165
——, The Visibility of the Dark Side of Venus .................... 338
Probable Errors of Meridian Observations in Declination ......... 386
Publications, Sizes of................. 104
Pulkova Standard Catalogue for 1885 (Nyrén) .......... ...... 58, 206

**R.A.** and Declination, On a Photographic Plate Determination of (Dyson) ............................ 328
—— —— (Turner) ... ............... 357
Radcliffe Catalogue (1890), The ... 21
Rain-gauges .......................... 17
Raphael Cartoon Gallery, Lighting of the ............................... 105
Reference Book, A .................. [illegible]
Research, An Oxford Degree for... [illegible]
*Russell, Prof. S. M.*, Some Astronomical Records in ancient Chinese Books.............. 323, 355, 430
Rutherfurd, L. M., On Stellar Photography............................ 287

**S***ampson, R. A.*, Adams's determination of the Masses of Jupiter's Satellites............................ 293
Saturn's Rings, Constitution of 235, 404
—— ——, Dimensions of (Lewis). 404
—— ——, Rotation of .............. 251
—— ——, Keeler's Spectroscopic Observations of ..................... 227
Selenographic Notes (Elger) ... 52, 85, 117, 157, 196, 231, 271, 305, 334, 361, 389, 433
Skew Cassegrain, On the Geometrical Optics of the (Turner)......... 81
Smithsonian Geographical Tables. 205
Société Astronomique de France, Bulletin de la ..................... 102
Spectrum, Lines in the, due to imperfect driving ................. 320
Stanley's (W. F.) 'Nebular Theory' 399
Star, A new, in Carina......... 436, 443
—— Catalogue of the 'Astronomische Gesellschaft'.............. 339
STARS:—
  $\beta$ Cassiopeiæ, Parallax of ... 132,
  $\eta$ ——, —— .............. 246, 344
  4 Aquarii, Orbit of ........... 209
  $\mu^2$ Boötis, Orbit of ........... 375
  $\alpha$ Centauri ........................ 405
  $\kappa$ Pegasi, Orbit of ............... 247
  *h* Persei, The Cluster ......... 134
  $\Sigma$ 1516, The Group ........... 114
  $\sigma_2$ Ursæ Majoris, On the System (Lewis) ................... 83
  $\gamma$ Virginis, Orbit of ........... 374
Stars, Relations between Parallax, Magnitudes, and P.M. of......... 129
——, Red ......................... 68, 318
——, Variable ......................... 69
——, ——, Orange (Backhouse). 94, 165
——, ——, —— (Miss Brown) 120, 200
——, ——, —— (Noble)..... ...... 201

Page

Stellar Chromatics (Waugh) ...... 234
—— Systems ........................ 406
*Stockwell, J. N.*, Ancient Indian Eclipses .. ........................ 127
——, Chronology and Eclipses. 57, 161
*Stone, E. J.*, On the number of Figures necessary in Reductions 391
Sun, Rotation Period of the... 133, 341
Sun-spots, Wilsonian Theory of... 67
——, Periodicity of ................. 104

Taylor's (Miss L.) 'Elementary History of Astronomy' ......... 368
Telescopes, Comparative Usefulness of Large and Small ......... 316
Time, Unification of Civil and Astronomical ........................ 131
Turner's (A.) 'Kraft und Materie im Raume' ........................ 63
*Turner, Prof. H. H.*, Formulæ for converting Measures on a Photographic Plate into R.A. and Declination ........................ 351
——, On the Number of Figures necessary in Reductions of Apparent Star-places ................. 424
——, The Geometrical Optics of the Skew Cassegrain Telescope . 81

Page

Variable Stars .................... 69, 318
—— Orange Stars (Backhouse, Brown, Noble) ...... 94, 120, 165, 200
Velocity of Stars in the Line of Sight, A new method of determining (Orbinsky, Frost) ...... 303, 393, 394
Venus, Visibility of the Dark Side of (Prince, Lynn) ........... 338, 362

Watson Trustees, Report of the... 266 345
*Waugh, Rev. W. R.*, Periodicity of Jupiter's Markings ............... 311
——, Stellar Chromatics ........... 234
Weather Notes ...... 67, 102, 131, 249, 287, 316, 373, 407
Wells's (H. G.) 'Time Machine'. 321

Zenith Telescope, A new form of . 208
Zone Time System, The ...... 131, 173, 174, 210, 250, 444

-166

222.] 1895. [*Price* 1*s.* 6*d.*

# COMPANION

TO

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

EDITED BY

H. H. TURNER, M.A., B.Sc., Sec. R.A.S.,
SAVILIAN PROFESSOR,
T. LEWIS, F.R.A.S.,
H. P. HOLLIS, B.A., F.R.A.S.

UNIVERSITY

## CONTENTS.

PAGE

Introduction ........ 1
The Sun.—Phases of the Moon ........ 2
Calendar, including Rising and Setting of the Moon and Longitude of Moon's Terminator ........ 3-5
List of the principal Meteor-showers of the Year, derived from recent Observations. By W. F. Denning ........ 6
Ephemeris for Mercury, Venus, Mars ........ 7
Ephemerides for Jupiter, Saturn, Uranus, Neptune ........ 8
Ephemeris for Ceres, Pallas, Juno, Vesta ........ 8
Eclipses in 1895 ........ 9
Occultations ........ 10-11
Phenomena and Configurations of Jupiter's Satellites ........ 12
Elongations of Jupiter's Satellites ........ 13-16
Elements of Jupiter's Vth Satellite ........ 17
Ephemeris for Satellites of Saturn ........ 19-21
Table of Bessel's Mean Refractions ........ 21
Ephemeris for Satellites of Uranus ........ 22-23
Ephemeris for Satellite of Neptune ........ 23
Ephemeris for Physical Observations of the Sun ........ 24
Long Period Variable Stars ........ 25-26
Ephemeris of Variable Stars of Short Period not of the Algol type ........ 27-28
[illegible] Elements ........ 28
Ephemeris of Variable Stars of the Algol type ........ 29-31
Maxima and Minima of Variable Stars ........ 32
Double Stars ........ 33-34

All Communications should be addressed to the **EDITORS** of the 'Observatory,' Royal Observatory, Greenwich, S.E.

Annual Subscription (for the "Companion" and twelve Monthly Numbers): 13 *shillings.*

LONDON:
PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS,
*RED LION COURT*, FLEET STREET, E.C.

## CONTENTS OF No. 220.

**Articles:—** PAGE

Notes on Mars in 1894. By A. Stanley Williams, F.R.A.S. ... ............... 347
The Comet on the Eclipse Photographs of 1893. By W. H. Wesley, F.R.A.S. 349
Note on the Spectrum of Mars. By Dr. W. Huggins, F.R.S. .................. 353
The Rotation of Venus. (Translation.) By Camille Flammarion ......... ... 354
George Knott. Obituary by B. Woodd-Smith, F.R.A.S. ....................... .. 355
Ephemeris of Jupiter's Fifth Satellite ............... ..... ........................ 356
Selenographical Notes. By T. G. Elger, F.R.A.S. .................................. 357

**Correspondence:—**

Encke's Comet. By W. T. Lynn, B.A., F.R.A.S. ........................................ 359
Publication of the "Life, Letters, and Papers" of the late Prebendary Webb. By S. Maitland Baird Gemmill ........................................ 360
The Chinese Astronomers, Hi and Ho. By F. W. Henkel, Jun. ............... 361
An early unobserved Transit of Mercury. By the Rev. S. J. Johnson, F.R.A.S. 361

**Observatories:—**

Continental ...... ........................................................ 362-364

**Publications:—**

The Pulkowa Star Catalogue. Epoch 1885.—Theophrastus on Winds and Weather-Signs. Lick Observatory Publications.—A Journey in Other Worlds.—Celestial Objects for Common Telescopes. Vol. II. ......... 364-369

**Notes:—**

The Coronal Comet of 1893, April 16.—Comet Notes.—Nebulosity in the Neighbourhood of the Pleiades. The Changes in the Spectrum of $\beta$ Lyræ.—Method for determining Errors of a Meridian-Circle.—Attempt to determine the Date of the 'Rig-Veda' by Eclipses.—An 18th Century Comet.—British Astronomical Association.—United States Naval Observatory, Washington.—Editorial.—From an Oxford Note-Book ........................................ 370-378

---

**ON SALE** (the Owner giving up Astronomical Work).—The 3-foot Common Reflector, with or without Dome, complete, in perfect order. Mirror by Sir H. Grubb. Full particulars on application to

J. Gledhill, Bermerside Observatory, Halifax, England.

---

*Just published. Royal 4to size.*

A
SELECTION OF PHOTOGRAPHS
OF
**STARS, STAR-CLUSTERS, AND NEBULÆ,**
TOGETHER WITH INFORMATION CONCERNING
THE INSTRUMENTS AND THE METHODS EMPLOYED IN THE
PURSUIT OF CELESTIAL PHOTOGRAPHY.
BY
**ISAAC ROBERTS, D.Sc., F.R.S.**

LONDON:
The Universal Press, WITHERBY & CO., 326 High Holborn.

*A limited number of Copies of the Work may be obtained by Fellows of the Royal Astronomical Society and Members of the British Astronomical Association, at a special price, by application to the Secretaries.*

# JAMES POOLE & CO.,

## CHRONOMETER, CLOCK, & WATCH MANUFACTURERS,

**Contractors to the Admiralty, The Council of State for India, the Crown Agents for the Colonies, the War Office, the Italian Government, &c.**

BY SPECIAL APPOINTMENT.

*Fine Watches and Chronometers Repaired, &c.*

*SPECIALITY:*

**CHRONOGRAPH STOP WATCHES, AS SUPPLIED TO THE ROYAL NAVY.**

33 SPENCER STREET, CLERKENWELL, LONDON.

---

DIPLOMA AND MEDAL.

**Electrical Exhibition 1892, for non-magnetizable Watches**

(*See* Times, March 22, 1894, *and our Book on* Watches).

## S. SMITH & SON, 9 Strand, London,

WATCHMAKERS TO THE ADMIRALTY.

**Largest Stock of Kew Certificated Watches in the World in Silver Cases, from £8 10s.**

OUR SUCCESSES AT KEW OBSERVATORY WITH HIGH-CLASS WATCHES.

| Year. | Total Number of Watches sent by all Makers, English & Foreign. | Number of Watches gaining Distinction and Published in the Blue Book & Reports of the Royal Society. | Our Own. |
|---|---|---|---|
| 1888 | 560 | 12 | 2 |
| 1889 | 528 | 10 | 4 |
| 1890 | 513 | 13 | 2 |
| 1891 | 700 | 17 | 2 |
| 1892 | 1044 | 17 | 2 |
| 1893 | 1521 | 18 | 2 |

AND **TWO** YEARS OUT OF THESE SIX WE HAVE HAD THE BEST WATCH OF THE YEAR.

*S. S. & SON'S 'Guide to the Purchase of a Watch' is the most complete one in existence. 144 pages and nearly 300 Illustrations.*

**Particulars on application.**

---

## CALVER'S "COMPLETE EQUATORIAL."

(*Letters Patent.*)

This New Model embraces many radical and important improvements, making the Newtonian Reflector complete and perfect. Particulars and Price-lists free.

New edition of "Hints on Reflectors," &c. &c., illustrated.

By G. CALVER, F.R.A.S., Widford, Chelmsford.

DIPLOMA OF HONOUR,

Highest Award, Inventions Exhibition, 1885, for Marine Chronometers and High-Class Watches.

**HENRY P. ISAAC,**

**Chronometer Maker to the Admiralty, the Indian, Italian, and Colonial Governments,**

*MAKER OF ALL KINDS OF TRUSTWORTHY WATCHES.*

**10 SPENCER STREET, LONDON, E.C.**

Eight and Two-day Chronometers, Keyless Pocket Chronometers, Repeaters, Chronographs, Deck Watches, and fine adjusted Levers, Plain and Keyless, kept in Stock.

---

**W. WRAY, Optician,**

MANUFACTURER OF

**ASTRONOMICAL AND TERRESTRIAL TELESCOPES,**

*EQUATORIAL and other MOUNTINGS, EYEPIECES, &c., &c.,*

MICROSCOPE OBJECTIVES AND MICROSCOPES,

**PHOTOGRAPHIC LENSES,**

LANTERN PROJECTION LENSES, &c., &c.

Illustrated Catalogue Free.

LAUREL HOUSE, NORTH HILL, HIGHGATE, LONDON, N.

---

**KENDAL & DENT,**

WATCHMAKERS TO THE ADMIRALTY,

THE ROYAL ITALIAN NAVY, etc.,

106 CHEAPSIDE, LONDON, E.C.

MANUFACTURERS OF

**Marine and Pocket Chronometers, Deck Watches, finely adjusted English Lever Watches, with Kew Observatory Certificates.**

*GOLD MEDAL PARIS INTERNATIONAL EXHIBITION, &c.*

*Large Illustrated Catalogue post-free on application.*

Pp. xi, 361 ; Demy 8vo. With 2 Plates and 65 Woodcuts. Price 10s.

# TELESCOPIC WORK FOR STARLIGHT EVENINGS.

BY

WILLIAM F. DENNING, F.R.A.S.

(Formerly President of the Liverpool Astronomical Society.)

## *EXTRACTS FROM REVIEWS.*

"As might be expected from such an experienced and enthusiastic observer as Mr. Denning, this book is thoroughly practical. He is not contented with describing the beauties of the skies, but gives invaluable information as how to see them best. To observers of limited means the book will be of the greatest assistance, both in the selection and use of their instruments. The book is full of important practical details. Every one who uses a telescope or intends to use one, of whatever dimensions, should read Mr. Denning's book."—*Nature.*

"There is a peculiar interest and fascination connected with the subject of Astronomy, which even the comparatively uneducated reader cannot but feel, and hence there exists here a field for popular presentation which is hardly equalled in any other branch of science. The present work is one of this class, and is fresh in matter, attractive and popular in style, and with its numerous illustrations cannot fail to bring pleasure and instruction to all who use it."—*American Journal of Science.*

Mr. Denning "writes as an observer of skill and experience, whilst the early chapters on the invention, history, and development of the telescope are replete with interest to all, but especially to those who are themselves astronomical observers."—*Athenæum.*

"It deserves to be read with respect and attention by every amateur astronomer; nor can the task prove anything but a pleasure to such as will genially commit themselves to the guidance of an author whose arbitrary dealings, here and there, with language impart a certain raciness to the ready and animated flow of his discourse. The want, moreover, of such an unpretending handbook is, we believe, genuinely felt. Many persons are the possessors of telescopes which they are at a loss how to employ. Intending observers cannot do better, under these circumstances, than place themselves under Mr. Denning's guidance. The book is suitably and sufficiently illustrated, in large measure from the author's original drawings." *Saturday Review, May 23.*

"Mr. Denning is universally recognized as one of the greatest living authorities on the subject of Meteoric Astronomy. A work from his pen will therefore be read with much interest and expectation by all lovers of the sublime science, and his readers will not be disappointed. This is a very interesting and valuable work, and all telescopists should procure a copy without delay."—*Philosophical Magazine* (J. E. Gore).

"Mr. Denning is so well known as a patient observer of meteors and comets that a work from him on observational astronomy will be looked upon with special interest." *Knowledge.*

"The illustrations are numerous and well executed and there is a fairly copious index. Mr. Denning's work will we trust have a large circulation, for it thoroughly deserves it. The book would make an admirable addition to the shelves of a lending library."—*Bristol Times and Mirror.*

"Since the appearance of Webb's '*Celestial Objects for Common Telescopes*' I much doubt if any work more useful to the amateur observer (and notably to the beginner) has appeared than '*Telescopic Work for Starlight Evenings.*' One conspicuous merit of Mr. Denning's excellent book lies in the fact that it is obviously written by a man possessing the most thorough personal familiarity with the objects he so lucidly describes."—"*F.R.A.S." in English Mechanic.*

"Mr. Denning has written in a straightforward earnest fashion that must not only make many difficulties clear to his readers but inspire them with something of his own determination and enthusiasm."—*Observatory.*

"A glance at its table of contents will interest any reader of Astronomy who knows anything of the Author's ability as a practical astronomer and a ready writer on general astronomical themes." —*Sidereal Messenger.*

"Would-be purchasers of telescopes are assisted with sound advice, would-be workers with telescopes are supplied with stimulating suggestions."—*Journal of the British Astronomical Association.*

"Mr. Denning is one of the keenest, most unwearying observers in England, and the book is worthy of his reputation."—*Weekly Mail.*

LONDON:

**TAYLOR & FRANCIS**, Red Lion Court Fleet Street.

1891.

## WORKS PUBLISHED BY TAYLOR AND FRANCIS.

**The London, Edinburgh, and Dublin Philosophical Magazine.** Monthly. 2s. 6d.
**The Annals and Magazine of Natural History.** Monthly. 2s. 6d.
**The Observatory, Monthly Review of Astronomy.** 1s.
**Aelfric Society's Publications.** 15 parts. 37s. 6d.
**Aëronautics, by Brewer and Alexander.** 6s.
**Aitchison's (J. E. T.) Catalogue of Plants of Punjab.** 10s.
**Anderson's Fauna of Mergui Archipelago.** Vol. I. 30s., Vol. II. 15s.
**Baird's (Major) Manual for Tidal Observations.** 7s. 6d.
**Belville's Manual for Thermometer.** 1s.
**Blakesley's Table of Hyperbolic Sines and Cosines.** 1s.
**Chimmo's (Capt.) Natural History of Euplectella aspergillum.** 5s.
**Daubeny on Volcanos.** 21s.
**Davis's (J. B.) Crania Britannica,** £6 10s. **Thesaurus Craniorum,** 20s.
**Denning's Telescopic Work for Starlight Evenings.** 10s.
**Douse's Introduction to Gothic of Ulfilas.** 10s. 6d.
**English Poetry in use at Charterhouse School.** 3s. 6d.
**Examination Papers set by Examining Board of Physicians and Surgeons.** 6d.
**Ditto for Diploma in Public Health.** 6d.
**Faraday's Experimental Researches in Chemistry and Physics.** 15s.
**Fauna of British India.** Edited by W. T. Blanford, F.R.S.
**Mammalia.** 20s. **Fishes.** 2 vols. 20s. each.
**Birds.** Vol. I. 20s. Vol. II. 15s. **Reptilia and Batrachia.** 20s.
**Moths.** Vol. I. 20s. Vol. II. 20s.
**Geological Record.** 1874-1884. 8 vols. 50s.
**Glaisher's Barometer Tables.** 1s. **Diurnal Range Tables,** 1s. 6d.
**Glaisher's Hygrometrical Tables.** 2s. 6d.
**Glaisher's Factor Tables for Fourth, Fifth, and Sixth Millions.** 20s. each.
**Hopkins's (E.) Geology and Terrestrial Magnetism.** 8vo. Cloth. 10s.
**Ditto. Illustrated Introduction to.** 8vo. Cloth. 4s.
**Joule's Scientific Papers.** Vol. I. 20s. Vol. II. 12s.
**Lewis's (G.) Catalogue of Japanese Coleoptera.** 2s. 6d.; on one side, 3s. 6d.
**London Hospital Pathological Catalogue.** 7s. 6d. nett.
**Manchester Lit. and Phil. Society, Memoirs.** Vols. 8 and 10. 7s. each.
**M'Intosh's Marine Invertebrates and Fishes of St. Andrews.** 21s.
**Merington's French Primer,** 2s. 6d. **English Primer,** 1s.
**Merington's French Pronunciation.** 2s. 6d.
**Merington's Latin First Course, with Key.** 3s. 6d.
**Olsen's (O. T.) Piscatorial Atlas.** Coloured, 52s. 6d.; uncoloured, 42s.
**Pascoe's Classes, Orders, &c. of the Animal Kingdom.** 3s. 6d.
**Pascoe's List of British Vertebrate Animals.** 1s.
**Pascoe's Student's List of British Coleoptera.** 4s. 6d.
**Phillips's Geology of Yorkshire.** 2 vols. 30s.
**Physical Memoirs, translated from foreign sources.** Vol. I. Part I. 4s., Part II. 7s. 6d., Part III. 6s.
**Reade's Origin of Mountain-Ranges.** 21s.
**Royal College of Surgeons Calendar.** 1s.
**Catalogue of Specimens illustrating the Osteology of Vertebrate Animals in Museum.** Part 3 **Aves.** 12s.
**Appendices 5, 6, and 7 to the Second Edition of Descriptive Catalogue of the Pathological Specimens in Museum.** 2s. each.
**Sharp's (Dr. D.) Staphylinidæ of Japan.** 3s. 6d.
**Smith's (R. A.) Centenary of Science in Manchester.** 10s.
**Taylor's Scientific Memoirs.** Ser. 1. £6 6s.; Ser. 2, £1 4s.
**Thomson's (Sir W.) Tables for facilitating Sumner's Method at Sea.** 10s. 6d. **Forms for ditto.** 8vo, 1s. Sheets, 1s.
**Univ. Coll. London Calendar.** 2s. 6d. **Pathological Catalogue.** Parts 1 to 3, 2s. each; Part 4, 1s. **Library Catalogue,** 3 Vols. 7s. 6d.
**Univ. Coll. Medical and Biological Catalogue.** 2s 6d.
**Walker's (Rev. R.) Constitution of Sun.** 3s.
**Wheatstone's (Sir C.) Scientific Papers.** 15s.
**Wiegmann's Herpetologia Mexicana.** Part I. Coloured Plates. 40s.
**Wollaston's Notes on Lepidoptera of St. Helena.** 3s. 6d.

RED LION COURT, FLEET STREET, LONDON, E.C.

**Maker to the Admiralty, the Council of State for India. and the Crown Agents for the Colonies; the Austrian, Italian, and Portuguese Governments. By Special Appointment to the King of Sweden and Norway.**

# V. KULLBERG,

105 Liverpool Road, London, N.

**CHRONOMETER AND WATCH MANUFACTURER.**

EVERY DESCRIPTION OF HIGH-CLASS KEYLESS AND ORDINARY WATCHES.

PRESENTATION WATCHES.

Awarded Nine Gold Medals and Four Diplomas of Honour (Highest Awards).

**FIRST PRIZE, WITH THE FREEDOM OF THE CLOCKMAKERS' COMPANY OF THE CITY OF LONDON, 1881.**

Chronometers with Kullberg's new balances and other improvements have stood First or Second *twenty-two times* at the Royal Observatory, Greenwich; and of these, three were *the best ever tried at Greenwich.*

Two First-class Awards at Sydney Exhibition (1880): and although the watches were not intended for the competitive trial, they obtained higher marks than those of any other exhibitor.

Dr. Gill, now Astronomer Royal at the Cape, wrote:—"Of the 50 chronometers used, Kullberg 488 has, on the whole, performed best. Allow me to express the great satisfaction I have had in all the chronometers of your make in the expedition to Mauritius" (Lord Crawford's Transit of Venus Expedition, 1874).

---

SYMONS'S

# MONTHLY METEOROLOGICAL MAGAZINE.

*Monthly price 4d., or 5s. per annum, post-free.*

**THE OLDEST INDEPENDENT METEOROLOGICAL SERIAL,**
**having been established in 1866.**

*CIRCULATES IN ALL PARTS OF THE WORLD.*

Contains early notice of all new Discoveries, Theories, Phenomena, Instruments, and Publications of interest to Meteorologists, Reviews, Correspondence, and details of Climate not only in the British Isles but throughout the Empire.

LONDON:
EDWARD STANFORD, COCKSPUR STREET, S.W.
AND ALL BOOKSELLERS.

---

# HEWITT & SON,

**CHRONOMETER MAKERS**

TO THE

RIGHT HONOURABLE THE LORDS COMMISSIONERS OF THE ADMIRALTY (since 1830).

*344 City* **Road. Islington, London, E.C.**

# E. DENT & CO.,

**61 STRAND and 4 ROYAL EXCHANGE**
(Factory: **4 HANWAY PLACE, W.**),
**LONDON.**

MANUFACTURERS OF
**ASTRONOMICAL CLOCKS,**
GALVANIC CHRONOGRAPHS, WATCHES,
**CHRONOMETERS, SHIPS' COMPASSES,**
TO HER MAJESTY and H.R.H. THE PRINCE OF WALES.

MAKERS OF
**THE GREAT WESTMINSTER CLOCK**
AND OF THE
NEW STANDARD CLOCK
OF
THE ROYAL OBSERVATORY, GREENWICH
AND OF
**STANDARD CLOCKS AND CHRONOGRAPHS**
FOR THE
GREENWICH, EDINBURGH, OXFORD, DUNSINK, PULKOWA,
BRUSSELS, GENEVA, &c. OBSERVATORIES;

MANUFACTURERS OF
**STANDARD AZIMUTH SHIPS' COMPASSES**
AND
MARINE [illegible]
FOR THE
BRITISH, AUSTRO-HUNGARIAN, ITALIAN, RUSSIAN,
GERMAN, SPANISH, JAPANESE, AND OTHER FOREIGN
AND COLONIAL GOVERNMENTS.

---

CATALOGUES ON APPLICATION.

---

61 STRAND and 4 ROYAL EXCHANGE,
LONDON.

LELAND STANFORD JUNIOR UNIVERSITY LIBRARY
JAN 21 1895

No. 223.] JANUARY, 1895. [Price 1s.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

EDITED BY

H. H. TURNER, M.A., B.Sc., Sec. R.A.S.,
SAVILIAN PROFESSOR,

T. LEWIS, F.R.A.S.,

H. P. HOLLIS, B.A., F.R.A.S.

## CONTENTS.

Page
Meeting of the Royal Astronomical Society on December 14, 1894 ..... 35
Meeting of the British Astronomical Association on November 28 ..... 45
Meeting of the Royal Meteorological Society on December 19 ..... 46

**Obituary**:—
Father Denza, Charles Frederick W. Peters, and A. Cowper Ranyard ..... 47, 48

**Articles**:—
On selecting Suitable Nights for observing Planetary Spectra. By Prof. W. W. Campbell ..... 50
Selenographical Notes. By T. G. Elger, F.R.A.S. ..... 52
Mars ..... 53

**Correspondence**:—
The Perseid Radiant. By W. H. S. Monck, F.R.A.S. ..... 55
Chronology and Eclipses. By John N. Stockwell, F.R.A.S. ..... 57
On the Poulkova Standard Catalogue for 1855.0. By M. Nyrén. ..... 58
De Vico's Periodical Comet (1844 I.). By W. F. Denning, F.R.A.S. ..... 60
The supposed Chinese Eclipse of the 'Shu Ching.' By W. T. Lynn, B.A., F.R.A.S. ..... 61

**Publications**:—
Elements of Astronomy. Pubblicazioni della Specola Vaticana, Vol. II.—Kraft und Materie im Raume ..... 62, 63

**Notes**:—
Comet Notes.—Minor Planet Notes.—A 12½-inch Equatorial for Rio Janeiro.—L'Astronomie.—Astro-Physical Journal, late Astronomy and Astro-Physics.—A new Orion Nebula. The December Gale.—Sun-spots.—Editorial.—From an Oxford Note-Book ..... 64–70

**All Communications should be addressed to the EDITORS of the 'Observatory,' Royal Observatory, Greenwich, S.E.**

Annual Subscription (for the "Companion" and twelve Monthly Numbers):—13 *shillings*.

LONDON:
PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS,
*RED LION COURT, FLEET STREET, E.C.*

## CONTENTS OF No. 221.

Titlepage and Index to Vol. XVII.

PAGE

Meeting of the Royal Astronomical Society on November 9 ........................ 379

Meeting of the British Astronomical Association on October 31 ............. 389

Meeting of the Royal Meteorological Society on November 21 ..................... 390

**Articles:—**

Notes on Mars in 1894. By A. Stanley Williams, F.R.A.S. .............. 391

On the Recurrence of Transits of Mercury. By A. C. D. Crommelin ........ 394

Selenographical Notes. By T. G. Elger, F.R.A.S. .................................. 397

The recent Transit of Mercury ..................................................... 399

Mars ....................................................................................... 401

**Correspondence:—**

The approaching Return of Barnard's Comet of 1884. By W. T. Lynn, B.A., F.R.A.S. ........................................ 402

Two new Variable Stars. By T. W. Backhouse, F.R.A.S. ..................... 402

**Notes:—**

Comet Notes.—Minor Planet Notes.—Mr. R. A. Sampson on Solar Physics.—Motions of Sun-spots.—Bright Projections on Mars.—Spectrum of Mars. Large Telescope.—Mr. Edwin Clark. Weather in November.—Magnetic Storm. Editorial.—From an Oxford Note-book ...... 402-410

---

**ON SALE** (the Owner giving up Astronomical Work).—The 3-foot Common Reflector, with or without Dome, complete, in perfect order. Mirror by Sir H. Grubb. Full particulars on application to

J. GLEDHILL, Bermerside Observatory, Halifax, England.

---

*Just published. Royal 4to size.*

A

SELECTION OF PHOTOGRAPHS

OF

**STARS, STAR-CLUSTERS, AND NEBULÆ,**

TOGETHER WITH INFORMATION CONCERNING
THE INSTRUMENTS AND THE METHODS EMPLOYED IN THE
PURSUIT OF CELESTIAL PHOTOGRAPHY.

BY

**ISAAC ROBERTS, D.Sc., F.R.S.**

LONDON
The Universal Press, WITHERBY & CO., 326 High Holborn.

*A limited number of Copies of the Work may be obtained by Fellows of the Royal Astronomical Society and Members of the British Astronomical Association, at a special price, by application to the Secretaries.*

DIPLOMA OF HONOUR,
Highest Award, Inventions Exhibition, 1885, for Marine Chronometers and High-Class Watches.

**HENRY P. ISAAC,**
**Chronometer Maker to the Admiralty, the Indian, Italian, and Colonial Governments,**

*MAKER OF ALL KINDS OF TRUSTWORTHY WATCHES.*

**10 SPENCER STREET, LONDON, E.C.**

**Eight and Two-day** Chronometers, Keyless Pocket Chronometers, **Repeaters,** Chronographs, Deck Watches, and fine adjusted Levers, Plain and Keyless, kept in Stock.

---

**W. WRAY, Optician,**

MANUFACTURER OF

**ASTRONOMICAL AND TERRESTRIAL TELESCOPES,**
***EQUATORIAL and other MOUNTINGS, EYEPIECES, &c., &c.,***
**MICROSCOPE OBJECTIVES AND MICROSCOPES.**
**PHOTOGRAPHIC LENSES,**
LANTERN PROJECTION LENSES, &c., &c.

ILLUSTRATED CATALOGUE FREE.

LAUREL HOUSE, NORTH HILL, HIGHGATE, LONDON, N.

---

**KENDAL & DENT,**

WATCHMAKERS TO THE ADMIRALTY,
THE ROYAL ITALIAN NAVY, etc.,

**106 CHEAPSIDE, LONDON, E.C.**

MANUFACTURERS OF

**Marine and Pocket Chronometers, Deck Watches, finely adjusted English Lever Watches, with Kew Observatory Certificates.**

*GOLD MEDAL PARIS INTERNATIONAL EXHIBITION, &c.*
Large Illustrated Catalogue post-free on application.

**JAMES POOLE & CO.,**

**CHRONOMETER, CLOCK, & WATCH MANUFACTURERS,**

**Contractors to the Admiralty, The Council of State for India, the Crown Agents for the Colonies, the War Office, the Italian Government, &c.**

**BY SPECIAL APPOINTMENT.**

*Fine Watches and Chronometers Repaired, &c.*

*SPECIALITY:*

**CHRONOGRAPH STOP WATCHES, AS SUPPLIED TO THE ROYAL NAVY.**

**33 SPENCER STREET, CLERKENWELL, LONDON.**

DIPLOMA AND MEDAL.

**Electrical Exhibition 1892, for non-magnetizable Watches**
(*See* TIMES, March 22, 1894, *and our Book on* WATCHES).

**S. SMITH & SON, 9 Strand, London,**

WATCHMAKERS TO THE ADMIRALTY.

**Largest Stock of Kew Certificated Watches in the World in Silver Cases, from £8 10s.**

OUR SUCCESSES AT KEW OBSERVATORY WITH HIGH-CLASS WATCHES.

| Year. | Total Number of Watches sent by all Makers, English & Foreign. | Number of Watches gaining Distinction and Published in the Blue Book & Reports of the Royal Society. | Our Own. |
|---|---|---|---|
| 1888 | 569 | 12 | 2 |
| 1880 | 528 | 19 | 4 |
| 1890 | 513 | 13 | 2 |
| 1891 | 709 | 17 | 2 |
| 1892 | 1044 | 17 | 2 |
| 1893 | 1521 | 18 | 2 |

AND **TWO** YEARS OUT OF THESE SIX WE HAVE HAD THE BEST WATCH OF THE YEAR.

*S. S. & SON'S 'Guide to the Purchase of a Watch' is the most complete one in existence. 144 pages and nearly 300 illustrations.*

**Particulars on application.**

**CALVER'S "COMPLETE EQUATORIAL."**

(*Letters Patent.*)

This New Model embraces many radical and important improvements, making the NEWTONIAN REFLECTOR complete and perfect. **Particulars and Price-lists free.**

New edition of "HINTS ON REFLECTORS," &c. &c., **illustrated.**

By G. CALVER, F.R.A.S., Widford, Chelmsford.

Pp. xi, 361; Demy 8vo. With 2 Plates and 65 Woodcuts. Price 10s.

# TELESCOPIC WORK FOR STARLIGHT EVENINGS.

BY

WILLIAM F. DENNING, F.R.A.S.

(Formerly President of the Liverpool Astronomical Society.)

## *EXTRACTS FROM REVIEWS.*

"As might be expected from such an experienced and enthusiastic observer as Mr. Denning, this book is thoroughly practical. He is not contented with describing the beauties of the skies, but gives invaluable information as how to see them best. To observers of limited means the book will be of the greatest assistance, both in the selection and use of their instruments. The book is full of important practical details. Every one who uses a telescope or intends to use one, of whatever dimensions, should read Mr. Denning's book."—*Nature.*

"There is a peculiar interest and fascination connected with the subject of Astronomy, which even the comparatively uneducated reader cannot but feel, and hence there exists here a field for popular presentation which is hardly equalled in any other branch of science. The present work is one of this class, and is fresh in matter, attractive and popular in style, and with its numerous illustrations cannot fail to bring pleasure and instruction to all who use it."—*American Journal of Science.*

Mr. Denning "writes as an observer of skill and experience, whilst the early chapters on the invention, history, and development of the telescope are replete with interest to all, but especially to those who are themselves astronomical observers."—*Athenæum.*

"It deserves to be read with respect and attention by every amateur astronomer; nor can the task prove anything but a pleasure to such as will genially commit themselves to the guidance of an author whose arbitrary dealings, here and there, with language impart a certain raciness to the ready and animated flow of his discourse. The want, moreover, of such an unpretending handbook is, we believe, genuinely felt. Many persons are the possessors of telescopes which they are at a loss how to employ. Intending observers cannot do better, under these circumstances, than place themselves under Mr. Denning's guidance. The book is suitably and sufficiently illustrated, in large measure from the author's original drawings."—*Saturday Review, May 23.*

"Mr. Denning is universally recognized as one of the greatest living authorities on the subject of Meteoric Astronomy. A work from his pen will therefore be read with much interest and expectation by all lovers of the sublime science, and his readers will not be disappointed. This is a very interesting and valuable work, and all telescopists should procure a copy without delay."—*Philosophical Magazine* (J. E. Gore).

"Mr. Denning is so well known as a patient observer of meteors and comets that a work from him on observational astronomy will be looked upon with special interest."—*Knowledge.*

"The illustrations are numerous and well executed and there is a fairly copious index. Mr. Denning's work will we trust have a large circulation, for it thoroughly deserves it. The book would make an admirable addition to the shelves of a lending library."—*Bristol Times and Mirror.*

"Since the appearance of Webb's '*Celestial Objects for Common Telescopes*' I much doubt if any work more useful to the amateur observer (and notably to the beginner) has appeared than '*Telescopic Work for Starlight Evenings.*' One conspicuous merit of Mr. Denning's excellent book lies in the fact that it is obviously written by a man possessing the most thorough personal familiarity with the objects he so lucidly describes."—"*F.R.A.S.*" *in English Mechanic.*

"Mr. Denning has written in a straightforward earnest fashion that must not only make many difficulties clear to his readers but inspire them with something of his own determination and enthusiasm."—*Observatory.*

"A glance at its table of contents will interest any reader of Astronomy who knows anything of the Author's ability as a practical astronomer and a ready writer on general astronomical themes."—*Sidereal Messenger.*

"Would-be purchasers of telescopes are assisted with sound advice, would-be workers with telescopes are supplied with stimulating suggestions."—*Journal of the British Astronomical Association.*

"Mr. Denning is one of the keenest, most unwearying observers in England, and the book is worthy of his reputation."—*Weekly Mail.*

LONDON:
***TAYLOR & FRANCIS,*** **Red Lion Court Fleet Street.**
1891.

## WORKS PUBLISHED BY TAYLOR AND FRANCIS.

**The London, Edinburgh, and Dublin Philosophical Magazine.** Monthly. 2s. 6d.
**The Annals and Magazine of Natural History.** Monthly. 2s. 6d.
**The Observatory, Monthly Review of Astronomy.** 1s.
**Aelfric Society's Publications.** 15 parts. 37s. 6d.
**Aëronautics, by Brewer and Alexander.** 6s.
**Aitchison's (J. E. T.) Catalogue of Plants of Punjab.** 10s.
**Anderson's Fauna of Mergui Archipelago.** Vol. I. 30s., Vol. II. 15s.
**Baird's (Major) Manual for Tidal Observations.** 7s. 6d.
**Belville's Manual for Thermometer.** 1s.
**Blakesley's Table of Hyperbolic Sines and Cosines.** 1s.
**Chimmo's (Capt.) Natural History of Euplectella aspergillum.** 5s.
**Daubeny on Volcanos.** 21s.
**Davis's (J. B.) Crania Britannica,** £6 10s. **Thesaurus Craniorum,** 20s.
**Denning's Telescopic Work for Starlight Evenings.** 10s.
**Douse's Introduction to Gothic of Ulfilas.** 10s. 6d.
**English Poetry in use at Charterhouse School.** 3s. 6d.
**Examination Papers set by Examining Board of Physicians and Surgeons.** 6d.
**Ditto for Diploma in Public Health.** 6d.
**Faraday's Experimental Researches in Chemistry and Physics.** 15s.
**Fauna of British India.** Edited by W. T. Blanford, F.R.S.
**Mammalia.** 20s. **Fishes.** 2 vols. 20s. each.
**Birds.** Vol. I. 20s. Vol. II. 15s. **Reptilia and Batrachia.** 20s.
**Moths.** Vol. I. 20s. Vol. II. 20s.
**Geological Record.** 1874-1884. 8 vols. 50s.
**Glaisher's Barometer Tables,** 1s. **Diurnal Range Tables,** 1s. 6d.
**Glaisher's Hygrometrical Tables.** 2s. 6d.
**Glaisher's Factor Tables for Fourth, Fifth, and Sixth Millions.** 20s. each.
**Hopkins's (E.) Geology and Terrestrial Magnetism.** 8vo. Cloth. 10s.
**Ditto Illustrated Introduction to.** 8vo. Cloth. 4s.
**Joule's Scientific Papers.** Vol. I. 20s. Vol. II. 12s.
**Lewis's (G.) Catalogue of Japanese Coleoptera.** 2s. 6d.; on one side, 3s. 6d.
**London Hospital Pathological Catalogue.** 7s. 6d. nett.
**Manchester Lit. and Phil. Society, Memoirs.** Vols. 8 and 10. 7s. each
**M'Intosh's Marine Invertebrates and Fishes of St. Andrews.** 21s.
**Merington's French Primer,** 2s. 6d. **English Primer** 1s.
**Merington's French Pronunciation.** 2s. 6d.
**Merington's Latin First Course, with Key.** 3s. 6d.
**Olsen's (O. T.) Piscatorial Atlas.** Coloured, 52s. 6d.; uncoloured, 42s.
**Pascoe's Classes, Orders, &c. of the Animal Kingdom.** 3s. 6d.
**Pascoe's List of British Vertebrate Animals.** 4s.
**Pascoe's Student's List of British Coleoptera.** 4s. 6d.
**Phillips's Geology of Yorkshire.** 2 vols. 30s.
**Physical Memoirs, translated from foreign sources.** Vol. I. Part I. 4s., Part II. 7s. 6d., Part III. 6s.
**Reade's Origin of Mountain-Ranges.** 21s.
**Royal College of Surgeons Calendar.** 1s.
**Catalogue of Specimens illustrating the Osteology of Vertebrate Animals in Museum.** Part 3. **Aves.** 12s.
**Appendices 5, 6, and 7 to the Second Edition of Descriptive Catalogue of the Pathological Specimens in Museum.** 2s. each.
**Sharp's (Dr. D.) Staphylinidæ of Japan.** 3s. 6d.
**Smith's (R. A.) Centenary of Science in Manchester.** 10s.
**Taylor's Scientific Memoirs.** Ser. 1. £6 6s.; Ser. 2. £1 4s.
**Thomson's (Sir W.) Tables for facilitating Sumner's Method at Sea.** 10s. 6d. **Forms for ditto.** Sun, 1s. Stars, 1s.
**Univ. Coll. London Calendar.** 2s. 6d. **Pathological Catalogue,** Parts 1 to 3, 2s each; Part 4, 1s. **Library Catalogue,** 3 Vols. 7s. 6d.
**Univ. Coll. Medical and Biological Catalogue.** 2s. 6d.
**Walker's (Rev. R.) Constitution of Sun.** 3s.
**Wheatstone's (Sir C.) Scientific Papers.** 15s.
**Wiegmann's Herpetologia Mexicana.** Part I. Coloured Plates. 40s.
**Wollaston's Notes on Lepidoptera of St Helena.** 3s. 6d.

RED LION COURT, FLEET STREET, LONDON, E.C.

**Maker to the Admiralty, the Council of State for India, and the Crown Agents for the Colonies; the Austrian, Italian, and Portuguese Governments. By Special Appointment to the King of Sweden and Norway.**

# V. KULLBERG,

**105 Liverpool Road, London, N.**

**CHRONOMETER AND WATCH MANUFACTURER.**

EVERY DESCRIPTION OF HIGH-CLASS KEYLESS AND ORDINARY WATCHES.

PRESENTATION WATCHES.

Awarded Nine Gold Medals and Four Diplomas of Honour (Highest Awards).

**FIRST PRIZE, WITH THE FREEDOM OF THE CLOCKMAKERS' COMPANY OF THE CITY OF LONDON, 1881.**

Chronometers with Kullberg's new balances and other improvements have stood First or Second *twenty-two times* at the Royal Observatory, Greenwich: and of these, three were *the best ever tried at Greenwich*.

Two First-class Awards at Sydney Exhibition (1880): and although the watches were not intended for the competitive trial, they obtained higher marks than those of any other exhibitor.

Dr. Gill, now Astronomer Royal at the Cape, wrote:—"Of the 50 chronometers used, Kullberg 488 has, on the whole, performed best. Allow me to express the great satisfaction I have had in all the chronometers of your make in the expedition to Mauritius" (Lord Crawford's Transit of Venus Expedition, 1874).

---

SYMONS'S

# MONTHLY METEOROLOGICAL MAGAZINE.

*Monthly price 4d., or 5s. per annum, post-free.*

**THE OLDEST INDEPENDENT METEOROLOGICAL SERIAL,**
**having been established in 1866.**

*CIRCULATES IN ALL PARTS OF THE WORLD.*

Contains early notice of all new Discoveries, Theories, Phenomena, Instruments, and Publications of interest to Meteorologists, Reviews, Correspondence, and details of Climate not only in the British Isles but throughout the Empire.

LONDON:
EDWARD STANFORD, COCKSPUR STREET, S.W.
AND ALL BOOKSELLERS.

---

# HEWITT & SON,

**CHRONOMETER MAKERS**

TO THE

RIGHT HONOURABLE THE LORDS COMMISSIONERS OF *THE ADMIRALTY* (since 1830).

***344 City* Road, Islington, London, E.C.**

E. DENT & CO.,

61 STRAND and 4 ROYAL EXCHANGE

(Factory: 4 HANWAY PLACE, W.),

LONDON.

MANUFACTURERS OF

ASTRONOMICAL CLOCKS,

GALVANIC CHRONOGRAPHS, WATCHES,

CHRONOMETERS, SHIPS' COMPASSES,

TO HER MAJESTY and H.R.H. THE PRINCE OF WALES.

MAKERS OF

**THE GREAT WESTMINSTER CLOCK**

AND OF THE

NEW STANDARD CLOCK

OF

THE ROYAL OBSERVATORY, GREENWICH,

AND OF

**STANDARD CLOCKS AND CHRONOGRAPHS**

FOR THE

GREENWICH, EDINBURGH, OXFORD, DUNSINK, PULKOWA, BRUSSELS, GENEVA, &c. OBSERVATORIES;

MANUFACTURERS OF

STANDARD AZIMUTH SHIPS' COMPASSES

AND

MARINE CHRONOMETERS

FOR THE

BRITISH, AUSTRO-HUNGARIAN, ITALIAN, RUSSIAN, GERMAN, SPANISH, JAPANESE, AND OTHER FOREIGN AND COLONIAL GOVERNMENTS.

---

CATALOGUES ON APPLICATION.

---

61 STRAND and 4 ROYAL EXCHANGE,

LONDON.

No. 224.] FEBRUARY, 1895. [*Price* 1*s*.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

EDITED BY

H. H. TURNER, M.A., B.Sc., SEC. R.A.S.,
SAVILIAN PROFESSOR,

T. LEWIS, F.R.A.S.,

H. P. HOLLIS, B.A., F.R.A.S.

## CONTENTS.

PAGE
Meeting of the Royal Astronomical Society on January 11, 1895 .................. 71
Meeting of the Royal Meteorological Society on January 16 ..................... 79
Meeting of the British Astronomical Association on December 19, 1894 ......... 79

**Articles:—**

Note on the Geometrical Optics of the Skew Cassegrain. By Prof. H. H. TURNER, M.A., B.Sc. .......... 81
On the System $\sigma^2$ Ursæ Majoris Σ 1306. By T. LEWIS, F.R.A.S. .......... 83
Selenographical Notes. By T. G. ELGER, F.R.A.S. .......... 85
Prof. Newcomb's new Planetary Tables .......... 86

**Correspondence:—**

Latitude Determinations. By Prof. C. L. DOOLITTLE .......... 90
A magnificent Meteor. By W. F. GALE, F.R.A.S. .......... 91
Chronology and Eclipses. By W. T. LYNN, B.A., F.R.A.S. .......... 92
Meteors of 1895, Jan. 1. By W. F. DENNING, F.R.A.S. .......... 93
Variable Orange Stars. By T. W. BACKHOUSE, F.R.A.S. .......... 94

**Observatories:—**

Natal.—Albany.—Harvard .......... 95–98

**Publications:—**

A few Chapters in Astronomy.—The Planet Earth .......... 98–100

**Notes:—**

Comet Notes.—Minor Planet Notes.—Transit of Mercury of 1894 Nov. 10.—Barometer and Thermometer Variations in recent Gales.—Editorial.—From an Oxford Note-book .......... 100–106

**All Communications should be addressed to the EDITORS of the 'Observatory,' Royal Observatory, Greenwich, S.E.**

**Annual Subscription (for the "Companion" and twelve Monthly Numbers):—13 *shillings*.**

LONDON:
PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS,
*RED LION COURT, FLEET STREET, E.C.*

## CONTENTS OF No. 223.

PAGE

Meeting of the Royal Astronomical Society on December 14, 1894 .......... 35

Meeting of the British Astronomical Association on November 28 .......... 45

Meeting of the Royal Meteorological Society on December 19 .......... 46

**Obituary**:—

Father Denza, Charles Frederick W. Peters, and A. Cowper Ranyard .......... 47, 48

**Articles**:—

On selecting Suitable Nights for observing Planetary Spectra. By Prof. W. W. Campbell .......... 50

Selenographical Notes. By T. G. Elger, F.R.A.S .......... 52

Mars .......... 53

**Correspondence**:—

The Perseid Radiant. By W. H. S. Monck, F.R.A.S .......... 55

Chronology and Eclipses. By John N. Stockwell, F.R.A.S .......... 57

On the Poulkova Standard Catalogue for 1855·0. By M. Nyrén .......... 58

De Vico's Periodical Comet (1844 I.). By W. F. Denning, F.R.A.S. .......... 60

The supposed Chinese Eclipse of the 'Shu Ching.' By W. T. Lynn, B.A., F.R.A.S. .......... 61

**Publications**:—

Elements of Astronomy.—Publicazioni della Specola Vaticana, Vol. II.—Kraft und Materie im Raume .......... 62, 63

**Notes**:—

Comet Notes.—Minor Planet Notes.—A 12½-inch Equatorial for Rio Janeiro.—L'Astronomie.—Astro-Physical Journal, *late* Astronomy and Astro-Physics.—A new Orion Nebula.—The December Gale.—Sun-spots.—Editorial.—From an Oxford Note-Book .......... 64–70

---

**ON SALE** (the Owner giving up Astronomical Work).—The 3-foot Common Reflector, with or without Dome, complete, in perfect order. Mirror by Sir H. Grubb. Full particulars on application to

J. GLEDHILL, Bermerside Observatory, Halifax, England.

---

**FOR SALE.**—Telescope, Refractor, on Equatorial Mounting; objective 3½ in. Cast-iron pillar and driving-clock by Cooke, York. Eyepieces 60, 100, 120, 250, and terrestrial. Price **£50** complete.

Address: Wm. GRAY, Oriental Buildings, Hull.

---

**WANTED TO BUY** a large Library of Astronomical Works. Please send full particulars to

**E 5592**; care of RUDOLF MOSSE, Leipzig.

---

*Just published. Royal 4to size.*

A

SELECTION OF PHOTOGRAPHS

OF

**STARS, STAR-CLUSTERS, AND NEBULÆ.**

LONDON:

The Universal Press, Witherby & Co., 326 High Holborn.

DIPLOMA OF HONOUR,
Highest Award, Inventions Exhibition, 1885, for Marine Chronometers and High-Class Watches.

**HENRY P. ISAAC,**

**Chronometer Maker to the Admiralty, the Indian, Italian, and Colonial Governments,**

*MAKER OF ALL KINDS OF TRUSTWORTHY WATCHES.*

**10 SPENCER STREET, LONDON, E.C.**

Eight and Two-day Chronometers, Keyless Pocket Chronometers, Repeaters, Chronographs, Deck Watches, and fine adjusted Levers, Plain and Keyless, kept in Stock.

---

**W. WRAY, Optician,**

MANUFACTURER OF

**ASTRONOMICAL AND TERRESTRIAL TELESCOPES,**

***EQUATORIAL** and other MOUNTINGS, EYEPIECES, &c., &c.,*

MICROSCOPE OBJECTIVES AND MICROSCOPES.

**PHOTOGRAPHIC LENSES,**

LANTERN PROJECTION LENSES, &c., &c.

ILLUSTRATED CATALOGUE FREE.

LAUREL HOUSE, NORTH HILL, HIGHGATE, LONDON, N.

---

**KENDAL & DENT,**

WATCHMAKERS TO THE ADMIRALTY,

THE ROYAL ITALIAN NAVY, etc.,

106 CHEAPSIDE, LONDON, E.C.

MANUFACTURERS OF

**Marine and Pocket Chronometers, Deck Watches, finely adjusted English Lever Watches, with Kew Observatory Certificates.**

*GOLD MEDAL PARIS INTERNATIONAL EXHIBITION, &c.*

Large Illustrated Catalogue post-free on application.

## JAMES POOLE & CO.,

**CHRONOMETER, CLOCK, & WATCH MANUFACTURERS,**

**Contractors to the Admiralty, The Council of State for India, the Crown Agents for the Colonies, the War Office, the Italian Government, &c.**

**BY SPECIAL APPOINTMENT.**

*Fine Watches and Chronometers Repaired, &c.*

*SPECIALITY:*

**CHRONOGRAPH STOP WATCHES, AS SUPPLIED TO THE ROYAL NAVY.**

**33 SPENCER STREET, CLERKENWELL, LONDON.**

DIPLOMA AND MEDAL,
**Electrical Exhibition 1892, for non-magnetizable Watches**
(*See* TIMES, March 22, 1894, *and our Book on* WATCHES).

**S. SMITH & SON, 9 Strand, London,**
WATCHMAKERS TO THE ADMIRALTY.

**Largest Stock of Kew Certificated Watches in the World in Silver Cases, from £8 10s.**

OUR SUCCESSES AT KEW OBSERVATORY WITH HIGH-CLASS WATCHES.

| Year. | Total Number of Watches sent by all Makers, English & Foreign. | Number of Watches gaining Distinction and Published in the Blue Book & Reports of the Royal Society. | Our Own. |
|---|---|---|---|
| 1888 | 569 | 12 | 2 |
| 1889 | 528 | 10 | 4 |
| 1890 | 513 | 13 | 2 |
| 1891 | 709 | 17 | 2 |
| 1892 | 1044 | 17 | 2 |
| 1893 | 1521 | 18 | 2 |

AND **TWO** YEARS OUT OF THESE SIX WE HAVE HAD THE BEST WATCH OF THE YEAR.

*S. S. & SON'S 'Guide to the Purchase of a Watch' is the most complete one in existence, 144 pages and nearly 300 illustrations.*

**Particulars on application.**

**CALVER'S "COMPLETE EQUATORIAL."**

(*Letters Patent.*)

This New Model embraces many radical and important improvements, making the NEWTONIAN REFLECTOR complete and perfect. Particulars and Price-lists free.

New edition of "HINTS ON REFLECTORS," &c. &c., illustrated.
By G. CALVER, F.R.A.S., Widford, Chelmsford.

**Pp. xi, 361 ; Demy 8vo. With 2 Plates and 65 Woodcuts. Price 10s.**

## TELESCOPIC WORK FOR STARLIGHT EVENINGS.

BY

WILLIAM F. DENNING, F.R.A.S.

(Formerly President of the Liverpool Astronomical Society.)

*EXTRACTS FROM REVIEWS.*

**"As might be expected from such an experienced and enthusiastic observer as Mr. Denning, this book is thoroughly practical. He is not contented with describing the beauties of the skies, but gives invaluable information as how to see them best. To observers of limited means the book will be of the greatest assistance, both in the selection and use of their instruments. The book is full of important practical details. Every one who uses a telescope or intends to use one, of whatever dimensions, should read Mr. Denning's book."**—*Nature.*

**"There is a peculiar interest and fascination connected with the subject of Astronomy, which even the comparatively uneducated reader cannot but feel, and hence there exists here a field for popular presentation which is hardly equalled in any other branch of science. The present work is one of this class, and is fresh in matter, attractive and popular in style, and with its numerous illustrations cannot fail to bring pleasure and instruction to all who use it."**—*American Journal of Science.*

**Mr. Denning "writes as an observer of skill and experience, whilst the early chapters on the invention, history, and development of the telescope are replete with interest to all, but especially to those who are themselves astronomical observers."**—*Athenæum.*

**"It deserves to be read with respect and attention by every amateur astronomer; nor can the task prove anything but a pleasure to such as will genially commit themselves to the guidance of an author whose arbitrary dealings, here and there, with language impart a certain raciness to the ready and animated flow of his discourse. The want, moreover, of such an unpretending handbook is, we believe, genuinely felt. Many persons are the possessors of telescopes which they are at a loss how to employ. Intending observers cannot do better, under these circumstances, than place themselves under Mr. Denning's guidance. The book is suitably and sufficiently illustrated, in large measure from the author's original drawings."**—*Saturday Review, May 23.*

**"Mr. Denning is universally recognized as one of the greatest living authorities on the subject of Meteoric Astronomy. A work from his pen will therefore be read with much interest and expectation by all lovers of the sublime science, and his readers will not be disappointed. This is a very interesting and valuable work, and all telescopists should procure a copy without delay."**—*Philosophical Magazine* (J. E. GORE).

**"Mr. Denning is so well known as a patient observer of meteors and comets that a work from him on observational astronomy will be looked upon with special interest."**—*Knowledge.*

**"The illustrations are numerous and well executed and there is a fairly copious index. Mr. Denning's work will we trust have a large circulation, for it thoroughly deserves it. The book would make an admirable addition to the shelves of a lending library."**—*Bristol Times and Mirror.*

**"Since the appearance of Webb's '*Celestial Objects for Common Telescopes*' I much doubt it any work more useful to the amateur observer (and notably to the beginner) has appeared than '*Telescopic Work for Starlight Evenings.*' One conspicuous merit of Mr. Denning's excellent book lies in the fact that it is obviously written by a man possessing the most thorough personal familiarity with the objects he so lucidly describes."**—*"F.R.A.S." in English Mechanic.*

**"Mr. Denning has written in a straightforward earnest fashion that must not only make many difficulties clear to his readers but inspire them with something of his own determination and enthusiasm."**—*Observatory.*

**"A glance at its table of contents will interest any reader of Astronomy who knows anything of the Author's ability as a practical astronomer and a ready writer on general astronomical themes"**—*Sidereal Messenger.*

**"Would-be purchasers of telescopes are assisted with sound advice, would-be workers with telescopes are supplied with stimulating suggestions."**—*Journal of the British Astronomical Association.*

**"Mr. Denning is one of the keenest, most unwearying observers in England, and the book is worthy of his reputation."**—*Weekly Mail.*

LONDON:

***TAYLOR & FRANCIS,*** **Red Lion Court Fleet Street.**

**1891.**

## WORKS PUBLISHED BY TAYLOR AND FRANCIS.

**The London, Edinburgh, and Dublin Philosophical Magazine.** Monthly. 2*s.* 6*d.*
**The Annals and Magazine of Natural History.** Monthly. 2*s.* 6*d.*
**The Observatory, Monthly Review of Astronomy.** 1*s.*
**Aelfric Society's Publications.** 15 parts. 37*s.* 6*d.*
**Aëronautics, by Brewer and Alexander.** 6*s.*
**Aitchison's (J. E. T.) Catalogue of Plants of Punjab.** 10*s.*
**Anderson's Fauna of Mergui Archipelago.** Vol. I. 30*s.*, Vol. II. 15*s.*
**Baird's (Major) Manual for Tidal Observations.** 7*s.* 6*d.*
**Belville's Manual for Thermometer.** 1*s.*
**Blakesley's Table of Hyperbolic Sines and Cosines.** 1*s.*
**Chimmo's (Capt.) Natural History of Euplectella aspergillum.** 5*s.*
**Daubeny on Volcanos.** 21*s.*
**Davis's (J. B.) Crania Britannica,** £6 10*s.* **Thesaurus Craniorum,** 20*s.*
**Denning's Telescopic Work for Starlight Evenings.** 10*s.*
**Douse's Introduction to Gothic of Ulfilas.** 10*s.* 6*d.*
**English Poetry in use at Charterhouse School.** 3*s.* 6*d.*
**Examination Papers set by Examining Board of Physicians and Surgeons.** 6*d.*
**Ditto for Diploma in Public Health.** 6*d.*
**Faraday's Experimental Researches in Chemistry and Physics.** 15*s.*
**Fauna of British India.** Edited by W. T. Blanford, F.R.S.
  **Mammalia.** 20*s.* **Fishes.** 2 vols. 20*s.* each.
  **Birds.** Vol. I. 20*s.* Vol. II. 15*s.* **Reptilia and Batrachia.** 20*s.*
  **Moths.** Vol. I. 20*s.* Vol. II. 20*s.*
**Geological Record.** 1874-1884. 8 vols. 50*s.*
**Glaisher's Barometer Tables,** 1*s.* **Diurnal Range Tables,** 1*s.* 6*d.*
**Glaisher's Hygrometrical Tables.** 2*s.* 6*d.*
**Glaisher's Factor Tables for Fourth, Fifth, and Sixth Millions.** 20*s.* each.
**Hopkins's (E.) Geology and Terrestrial Magnetism.** 8vo. Cloth. 10*s.*
**Ditto Illustrated Introduction to.** 8vo. Cloth. 4*s.*
**Joule's Scientific Papers.** Vol. I. 20*s.* Vol. II. 12*s.*
**Lewis's (G.) Catalogue of Japanese Coleoptera.** 2*s.* 6*d.*; on one side, 3*s.* 6*d.*
**London Hospital Pathological Catalogue.** 7*s.* 6*d.* nett.
**Manchester Lit. and Phil. Society, Memoirs.** Vols. 8 and 10. 7*s.* each.
**M'Intosh's Marine Invertebrates and Fishes of St. Andrews.** 21*s.*
**Merington's French Primer,** 2*s.* 6*d.* **English Primer,** 1*s.*
**Merington's French Pronunciation.** 2*s.* 6*d.*
**Merington's Latin First Course, with Key.** 3*s.* 6*d.*
**Olsen's (O. T.) Piscatorial Atlas.** Coloured, 52*s.* 6*d.*; uncoloured, 42*s.*
**Pascoe's Classes, Orders, &c. of the Animal Kingdom.** 3*s.* 6*d.*
**Pascoe's List of British Vertebrate Animals.** 4*s.*
**Pascoe's Student's List of British Coleoptera.** 4*s.* 6*d.*
**Phillips's Geology of Yorkshire.** 2 vols. 30*s.*
**Physical Memoirs, translated from foreign sources.** Vol. I. Part I. 4*s.*, Part II. 7*s.* 6*d.*, Part III. 6*s.*
**Reade's Origin of Mountain-Ranges.** 21*s.*
**Royal College of Surgeons Calendar.** 1*s.*
**Catalogue of Specimens illustrating the Osteology of Vertebrate Animals in Museum.** Part 3. **Aves.** 12*s.*
**Appendices 5, 6, and 7 to the Second Edition of Descriptive Catalogue of the Pathological Specimens in Museum.** 2*s.* each.
**Sharp's (Dr. D.) Staphylinidæ of Japan.** 3*s.* 6*d.*
**Smith's (R. A.) Centenary of Science in Manchester.** 10*s.*
**Taylor's Scientific Memoirs.** Ser. 1. £6 6*s.*; Ser. 2, £1 4*s.*
**Thomson's (Sir W.) Tables for facilitating Sumner's Method at Sea.** 10*s.* 6*d.* **Forms for ditto.** Sun, 1*s.* Stars, 1*s.*
**Univ. Coll. London Calendar.** 2*s.* 6*d.* **Pathological Catalogue,** Parts 1 to 3, 2*s.* each; Part 4, 1*s.* **Library Catalogue,** 3 Vols. 7*s.* 6*d.*
**Univ. Coll. Medical and Biological Catalogue.** 2*s.* 6*d.*
**Walker's (Rev. R.) Constitution of Sun.** 3*s.*
**Wheatstone's (Sir C.) Scientific Papers.** 15*s.*
**Wiegmann's Herpetologia Mexicana.** Part I. Coloured Plates 40*s.*
**Wollaston's Notes on Lepidoptera of St. Helena.** 3*s.* 6*d.*

RED LION COURT, FLEET STREET, LONDON, E.C.

**Maker to the Admiralty, the Council of State for India, and the Crown Agents for the Colonies; the Austrian, Italian, and Portuguese Governments. By Special Appointment to the King of Sweden and Norway.**

## V. KULLBERG,

105 Liverpool Road, London, N.

**CHRONOMETER AND WATCH MANUFACTURER.**

EVERY DESCRIPTION OF HIGH-CLASS KEYLESS AND ORDINARY WATCHES.

PRESENTATION WATCHES.

Awarded Nine Gold Medals and Four Diplomas of Honour (Highest Awards).

**FIRST PRIZE, WITH THE FREEDOM OF THE CLOCKMAKERS' COMPANY OF THE CITY OF LONDON, 1881.**

CHRONOMETERS with Kullberg's new balances and other improvements have stood First or Second *twenty-two times* at the Royal Observatory, Greenwich; and of these, three were *the best ever tried at Greenwich.*

Two First-class Awards at Sydney Exhibition (1880); and although the watches were not intended for the competitive trial, they obtained higher marks than those of any other exhibitor.

DR. GILL, now Astronomer Royal at the Cape, wrote:—"Of the 50 chronometers used, Kullberg 488 has, on the whole, performed best. Allow me to express the great satisfaction I have had in all the chronometers of your make in the expedition to Mauritius" (Lord Crawford's Transit of Venus Expedition, 1874).

---

## SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE.

*Monthly price 4d., or 5s. per annum, post-free.*

**THE OLDEST INDEPENDENT METEOROLOGICAL SERIAL, having been established in 1866.**

*CIRCULATES IN ALL PARTS OF THE WORLD.*

Contains early notice of all new Discoveries, Theories, Phenomena, Instruments, and Publications of interest to Meteorologists, Reviews, Correspondence, and details of Climate not only in the British Isles but throughout the Empire.

LONDON:
EDWARD STANFORD, COCKSPUR STREET, S.W.
AND ALL BOOKSELLERS.

---

## HEWITT & SON,

**CHRONOMETER MAKERS**
TO THE
RIGHT HONOURABLE THE LORDS COMMISSIONERS OF THE ADMIRALTY (since 1830).

**344 City Road, Islington, London, E.C.**

E. DENT & CO.,
**61 STRAND and 4 ROYAL EXCHANGE**
**(Factory: 4 HANWAY PLACE, W.),**
**LONDON.**

MANUFACTURERS OF
ASTRONOMICAL CLOCKS,
GALVANIC CHRONOGRAPHS, WATCHES,
**CHRONOMETERS, SHIPS' COMPASSES,**
TO HER MAJESTY and H.R.H. THE PRINCE OF WALES.

MAKERS OF
**THE GREAT WESTMINSTER CLOCK**
AND OF THE
NEW STANDARD CLOCK
OF
THE ROYAL OBSERVATORY, GREENWICH,
AND OF
**STANDARD CLOCKS AND CHRONOGRAPHS**
FOR THE
**GREENWICH, EDINBURGH, OXFORD, DUNSINK, PULKOWA,**
**BRUSSELS, GENEVA, &c. OBSERVATORIES;**

MANUFACTURERS OF
STANDARD AZIMUTH SHIPS' COMPASSES
AND
MARINE CHRONOMETERS
FOR THE
**BRITISH, AUSTRO-HUNGARIAN, ITALIAN, RUSSIAN,**
**GERMAN, SPANISH, JAPANESE, AND OTHER FOREIGN**
**AND COLONIAL GOVERNMENTS.**

---

**CATALOGUES ON APPLICATION.**

---

*61 STRAND and 4 ROYAL EXCHANGE*
LONDON.

203

225.] MARCH, 1895. [*Price* 1s.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

EDITED BY
H. H. TURNER, M.A., B.Sc., Sec. R.A.S.,
SAVILIAN PROFESSOR,
T. LEWIS, F.R.A.S.,
H. P. HOLLIS, B.A., F.R.A.S.

## CONTENTS.

PAGE
nversary Meeting of the Royal Astronomical Society on February 8 .. . 107
eting of the British Astronomical Association on January 30 . . .. 109
eting of the Royal Meteorological Society on February 20 .. .. .. .. .. 111

ticles:—
rofessor Cayley.—Obituary by F. W. Dyson, M.A., F.R.A.S. .. .. .. 112
he Group Σ 1516. By Thomas Lewis, F.R.A.S. ........ .. .. .. 114
he Variation of Latitude .. .. .. .. .. .. 114
elenographical Notes. By T. G. Elger, F.R.A.S. .. .. .. .. 117

rrespondence:—
assini and the Principal Division in Saturn's Ring. By W. T. Lynn, B.A., F.R.A.S. .. .. .. .. .. 118
he Comet of 1525. By W. T. Lynn, B.A., F.R.A.S. .. .. .. .. 120
ariable Orange Stars. By Miss E. Brown..... .. .. .. 120
lanetary Spectra. By Prof. W. W. Campbell .. .. .. .. 121

servatories
Volsingham ...... .... .. .. .. .. 121

blications:
he Radcliffe Observatory Catalogue for 1890. The 'Nautical Almanac for 1898.' L'Annuaire du Bureau des Longitudes. Le Service Chronométrique à l'Observatoire de Genève, avec une étude des épreuves instituées dans d'autres Observatoires pour les Chronomètres de Poche. Annuaire de l'Observatoire Royal de Belgique. Remarkable Comets. 121–125

tes:—
omet Notes. Minor Planet Notes. Prof. Stockwell on Ancient Indian Eclipses. On the Distribution of Stars in the Milky Way. On the Relation between the Parallaxes of Stars, their Magnitudes, and their apparent Proper Motions.—The Probable Revolution of the Orbit of Phobos.—The Great Frost of February, 1895. Zone Time System. The Unification of Civil and Astronomical Time. γ Cassiopeiæ. New Savilian Professor.—Rotation Period of the Sun.—Astronomy and the Influenza. Total Lunar Eclipse of March 10. Editorial Notes.—From an Oxford Note-book .. .. .. .. 126–138

**All Communications should be addressed to the EDITORS of the 'Observatory,' Royal Observatory, Greenwich, S.E.**

Annual Subscription (for the "Companion" and twelve Monthly Numbers): 13 *shillings*.

LONDON:
PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET, E.C.

## CONTENTS OF No. 224.

PAGE
Meeting of the Royal Astronomical Society on January 11, 1895 ........ ........ 71
Meeting of the Royal Meteorological Society on January 16 .................. ..... 79
Meeting of the British Astronomical Association on December 19, 1894 ........ 79

**Articles**:—

Note on the Geometrical Optics of the Skew Cassegrain. By Prof. H. H. Turner, M.A., B.Sc. ...... 81
On the System $\sigma^2$ Ursæ Majoris Σ 1306. By T. Lewis, F.R.A.S. . ........... 83
Selenographical Notes. By T. G. Elger, F.R.A.S. ........................ .. .. 85
Prof. Newcomb's new Planetary Tables .... ............ . ...... ............ ... 86

**Correspondence**:—

Latitude Determinations. By Prof. C. L. Doolittle ...................... 90
A magnificent Meteor. By W. F. Gale, F.R.A.S. ........................ ... 91
Chronology and Eclipses. By W. T. Lynn, B.A., F.R.A.S. ................ 92
Meteors of 1895, Jan. 1. By W. F. Denning, F.R.A.S. ...................... 93
Variable Orange Stars. By T. W. Backhouse, F.R.A.S. ............. ........ 94

**Observatories**:—

Natal.—Albany.—Harvard ........................................................ 95-98

**Publications**:—

A few Chapters in Astronomy.—The Planet Earth....... ................... 98-100

**Notes**:—

Comet Notes.—Minor Planet Notes.—Transit of Mercury of 1894 Nov. 10.—Barometer and Thermometer Variations in recent Gales.—Editorial.—From an Oxford Note-book ..... ........... ......................... 100-106

---

**ON SALE** (the Owner giving up Astronomical Work).—The 3-foot Common Reflector, with or without Dome, complete, in perfect order. Mirror by Sir H. Grubb. Full particulars on application to

J. GLEDHILL, Bermerside Observatory, Halifax, England.

---

**FOR SALE.**—Telescope, Refractor, on Equatorial Mounting: objective 3½ in. Cast-iron pillar and driving-clock by Cooke, York. Eyepieces 60, 100, 120, 250, and terrestrial. Price **£50** complete.

Address: Wm. GRAY, Oriental Buildings, Hull.

---

**WANTED TO BUY** a large Library of Astronomical Works. Please send full particulars to

**E 5592**: care of RUDOLF MOSSE, Leipzig.

---

*Just published. Royal 4to size.*

A
SELECTION OF PHOTOGRAPHS
OF
STARS, STAR-CLUSTERS, AND NEBULÆ.

LONDON.
The Universal Press, WITHERBY & CO., 326 High Holborn.

DIPLOMA OF HONOUR,

Highest Award, Inventions Exhibition, 1885, for Marine Chronometers and High-Class Watches.

**HENRY P. ISAAC,**

**Chronometer Maker to the Admiralty, the Indian, Italian, and Colonial Governments,**

*MAKER OF ALL KINDS OF TRUSTWORTHY WATCHES.*

**10 SPENCER STREET, LONDON, E.C.**

Eight and Two-day Chronometers, Keyless Pocket Chronometers, Repeaters, Chronographs, Deck Watches, and fine adjusted Levers, Plain and Keyless, kept in Stock.

---

**W. WRAY, Optician,**

MANUFACTURER OF

**ASTRONOMICAL AND TERRESTRIAL TELESCOPES,**

***EQUATORIAL and other MOUNTINGS, EYEPIECES, &c., &c.,***

**MICROSCOPE OBJECTIVES AND MICROSCOPES.**

**PHOTOGRAPHIC LENSES,**

**LANTERN PROJECTION LENSES, &c., &c.**

ILLUSTRATED CATALOGUE FREE.

LAUREL HOUSE, NORTH HILL, HIGHGATE, LONDON, N.

---

**KENDAL & DENT,**

**WATCHMAKERS TO THE ADMIRALTY,**

**THE ROYAL ITALIAN NAVY, etc.,**

**106 CHEAPSIDE, LONDON, E.C.**

MANUFACTURERS OF

**Marine and Pocket Chronometers, Deck Watches, finely adjusted English Lever Watches, with Kew Observatory Certificates.**

*GOLD MEDAL PARIS INTERNATIONAL EXHIBITION, &c.*

Large Illustrated Catalogue post-free on application.

# JAMES POOLE & CO.,

CHRONOMETER, CLOCK, & WATCH MANUFACTURERS.

Contractors to the Admiralty, The Council of State for India, the Crown Agents for the Colonies, the War Office, the Italian Government, &c.

BY SPECIAL APPOINTMENT.

*Fine Watches and Chronometers Repaired, &c.*

*SPECIALITY:*

**CHRONOGRAPH STOP WATCHES, AS SUPPLIED TO THE ROYAL NAVY.**

33 SPENCER STREET, CLERKENWELL, LONDON.

---

DIPLOMA AND MEDAL.

**Electrical Exhibition 1892. for non-magnetizable Watches**

(*See* TIMES, March 22, 1894, *and our Book on* WATCHES).

**S. SMITH & SON, 9 Strand, London,**

WATCHMAKERS TO THE ADMIRALTY.

**Largest Stock of Kew Certificated Watches in the World in Silver Cases, from £8 10s.**

OUR SUCCESSES AT KEW OBSERVATORY WITH HIGH-CLASS WATCHES.

| Year. | Total Number of Watches sent by all Makers, English & Foreign. | Number of Watches gaining Distinction and Published in the Blue Book & Reports of the Royal Society. | Our Own. |
|---|---|---|---|
| 1888 | 569 | 12 | 2 |
| 1889 | 578 | 19 | 4 |
| 1890 | 513 | 13 | 2 |
| 1891 | 709 | 17 | 2 |
| 1892 | 1044 | 17 | 2 |
| 1893 | 1521 | 18 | 2 |

AND **TWO** YEARS OUT OF THESE SIX WE HAVE HAD THE BEST WATCH OF THE YEAR.

*S. S. & SON'S 'Guide to the Purchase of a Watch' is the most complete one in existence, 144 pages and nearly 300 illustrations.*

**Particulars on application.**

---

**CALVER'S "COMPLETE EQUATORIAL."**

(*Letters Patent.*)

This New Model embraces many radical and important improvements, making the NEWTONIAN REFLECTOR complete and perfect. **Particulars and Price-lists free.**

New edition of "HINTS ON REFLECTORS," &c. &c., illustrated.

By G. CALVER, F.R.A.S., Widford, Chelmsford.

**Pp. xi, 361 ; Demy 8vo. With 2 Plates and 65 Woodcuts. Price 10s.**

## TELESCOPIC WORK FOR STARLIGHT EVENINGS.

BY

WILLIAM F. DENNING, F.R.A.S.

(Formerly President of the Liverpool Astronomical Society.)

*EXTRACTS FROM REVIEWS.*

"As might be expected from such an experienced and enthusiastic observer as Mr. Denning, this book is thoroughly practical. He is not contented with describing the beauties of the skies, but gives invaluable information as how to see them best. To observers of limited means the book will be of the greatest assistance, both in the selection and use of their instruments. The book is full of important practical details. Every one who uses a telescope or intends to use one, of whatever dimensions, should read Mr. Denning's book." —*Nature.*

"There is a peculiar interest and fascination connected with the subject of Astronomy, which even the comparatively uneducated reader cannot but feel, and hence there exists here a field for popular presentation which is hardly equalled in any other branch of science. The present work is one of this class, and is fresh in matter, attractive and popular in style, and with its numerous illustrations cannot fail to bring pleasure and instruction to all who use it." —*American Journal of Science.*

Mr. Denning "writes as an observer of skill and experience, whilst the early chapters on the invention, history, and development of the telescope are replete with interest to all, but especially to those who are themselves astronomical observers."—*Athenæum.*

"It deserves to be read with respect and attention by every amateur astronomer, nor can the task prove anything but a pleasure to such as will genially commit themselves to the guidance of an author whose arbitrary dealings, here and there, with language impart a certain raciness to the ready and animated flow of his discourse. The want, moreover, of such an unpretending handbook is, we believe, genuinely felt. Many persons are the possessors of telescopes which they are at a loss how to employ. Intending observers cannot do better, under these circumstances, than place themselves under Mr. Denning's guidance. The book is suitably and sufficiently illustrated, in large measure from the author's original drawings." —*Saturday Review, May 23.*

"Mr. Denning is universally recognized as one of the greatest living authorities on the subject of Meteoric Astronomy. A work from his pen will therefore be read with much interest and expectation by all lovers of the sublime science, and his readers will not be disappointed. This is a very interesting and valuable work, and all telescopists should procure a copy without delay." *Philosophical Magazine* (J. E. Gore).

"Mr. Denning is so well known as a patient observer of meteors and comets that a work from him on observational astronomy will be looked upon with special interest." *Knowledge.*

"The illustrations are numerous and well executed and there is a fairly copious index. Mr. Denning's work will we trust have a large circulation, for it thoroughly deserves it. The book would make an admirable addition to the shelves of a lending library." —*Bristol Times and Mirror.*

"Since the appearance of Webb's '*Celestial Objects for Common Telescopes*' I much doubt if any work more useful to the amateur observer (and notably to the beginner) has appeared than '*Telescopic Work for Starlight Evenings.*' One conspicuous merit of Mr. Denning's excellent book lies in the fact that it is obviously written by a man possessing the most thorough personal familiarity with the objects he so lucidly describes." —"*F.R.A.S.*" *in English Mechanic.*

"Mr. Denning has written in a straightforward earnest fashion that must not only make many difficulties clear to his readers but inspire them with something of his own determination and enthusiasm." —*Observatory.*

"A glance at its table of contents will interest any reader of Astronomy who knows anything of the Author's ability as a practical astronomer and a ready writer on general astronomical themes." —*School Messenger.*

"Would-be purchasers of telescopes are assisted with sound advice, would-be workers with telescopes are supplied with stimulating suggestions."—*Journal of the British Astronomical Association.*

"Mr. Denning is one of the keenest, most unwearying observers in England, and the book is worthy of his reputation." —*Weekly Mail.*

LONDON:

***TAYLOR & FRANCIS***, Red Lion Court Fleet Street.

1891.

# WORKS PUBLISHED BY TAYLOR AND FRANCIS.

**The London, Edinburgh, and Dublin Philosophical Magazine.** Monthly. 2s. 6d.
**The Annals and Magazine of Natural History.** Monthly. 2s. 6d.
**The Observatory, Monthly Review of Astronomy.** 1s.
**Aelfric Society's Publications.** 15 parts. 37s. 6d.
**Aëronautics, by Brewer and Alexander.** 6s.
**Aitchison's (J. E. T.) Catalogue of Plants of Punjab.** 10s.
**Anderson's Fauna of Mergui Archipelago.** Vol. I. 30s., Vol. II. 15s.
**Baird's (Major) Manual for Tidal Observations.** 7s. 6d.
**Belville's Manual for Thermometer.** 1s.
**Blakesley's Table of Hyperbolic Sines and Cosines.** 1s.
**Chimmo's (Capt.) Natural History of Euplectella aspergillum.** 5s.
**Daubeny on Volcanos.** 21s.
**Davis's (J. B.) Crania Britannica,** £6 10s. **Thesaurus Craniorum,** 20s.
**Denning's Telescopic Work for Starlight Evenings.** 10s.
**Douse's Introduction to Gothic of Ulfilas.** 10s. 6d.
**English Poetry in use at Charterhouse School.** 3s. 6d.
**Examination Papers set by Examining Board of Physicians and Surgeons.** 6d.
**Ditto for Diploma in Public Health.** 6d.
**Faraday's Experimental Researches in Chemistry and Physics.** 15s.
**Fauna of British India.** Edited by W. T. Blanford, F.R.S.
**Mammalia.** 20s. **Fishes.** 2 vols. 20s. each.
**Birds.** Vol. I. 20s. Vol. II. 15s. **Reptilia and Batrachia.** 20s.
**Moths.** Vol. I. 20s. Vol. II. 20s.
**Geological Record.** 1874–1884. 8 vols. 50s.
**Glaisher's Barometer Tables,** 1s. **Diurnal Range Tables,** 1s. 6d.
**Glaisher's Hygrometrical Tables.** 2s. 6d.
**Glaisher's Factor Tables for Fourth, Fifth, and Sixth Millions.** 20s. each.
**Hopkins's (E.) Geology and Terrestrial Magnetism.** 8vo. Cloth. 10s.
**Ditto. Illustrated Introduction to.** 8vo. Cloth. 4s.
**Joule's Scientific Papers.** Vol. I. 20s. Vol. II. 12s.
**Lewis's (G.) Catalogue of Japanese Coleoptera.** 2s. 6d.; on one side, 3s. 6d.
**London Hospital Pathological Catalogue.** 7s. 6d. nett.
**Manchester Lit. and Phil. Society, Memoirs.** Vols. 8 and 10. 7s. each.
**M'Intosh's Marine Invertebrates and Fishes of St. Andrews.** 21s.
**Merington's French Primer,** 2s. 6d. **English Primer.** 1s.
**Merington's French Pronunciation.** 2s. 6d.
**Merington's Latin First Course, with Key.** 3s. 6d.
**Olsen's (O. T.) Piscatorial Atlas.** Coloured, 52s. 6d.; uncoloured, 42s.
**Pascoe's Classes, Orders, &c. of the Animal Kingdom.** 3s. 6d.
**Pascoe's List of British Vertebrate Animals.** 4s.
**Pascoe's Student's List of British Coleoptera.** 4s. 6d.
**Phillips's Geology of Yorkshire.** 2 vols. 30s.
**Physical Memoirs, translated from foreign sources.** Vol. I. Part I. 4s., Part II. 7s. 6d., Part III. 6s.
**Reade's Origin of Mountain-Ranges.** 21s.
**Royal College of Surgeons Calendar.** 1s.
**Catalogue of Specimens illustrating the Osteology of Vertebrate Animals in Museum.** Part 3. **Aves.** 12s.
**Appendices 5, 6, and 7 to the Second Edition of Descriptive Catalogue of the Pathological Specimens in Museum.** 2s. each.
**Sharp's (Dr. D.) Staphylinidæ of Japan.** 3s. 6d.
**Smith's (R. A.) Centenary of Science in Manchester.** 10s.
**Taylor's Scientific Memoirs.** Ser. 1. £6 6s.; Ser. 2. £1 4s.
**Thomson's (Sir W.) Tables for facilitating Sumner's Method at Sea.** 10s. 6d. **Forms for ditto.** Sun, 1s. Stars, 1s.
**Univ. Coll. London Calendar,** 2s. 6d. **Pathological Catalogue.** Parts 1 to 3, 2s. each; Part 4, 1s. **Library Catalogue.** 3 Vols. 7s. 6d.
**Univ. Coll. Medical and Biological Catalogue.** 2s. 6d.
**Walker's (Rev. R.) Constitution of Sun.** 3s.
**Wheatstone's (Sir C.) Scientific Papers.** 15s.
**Wiegmann's Herpetologia Mexicana.** Part I. Coloured Plates. 40s.
**Wollaston's Notes on Lepidoptera of St. Helena.** 3s. 6d.

RED LION COURT, FLEET STREET, LONDON, E.C.

Maker to the Admiralty, the Council of State for India, and the Crown Agents for the Colonies; the Austrian, Italian, and Portuguese Governments. By Special Appointment to the King of Sweden and Norway.

## V. KULLBERG,

105 Liverpool Road, London, N.

**CHRONOMETER AND WATCH MANUFACTURER.**

EVERY DESCRIPTION OF HIGH-CLASS KEYLESS AND ORDINARY WATCHES.

PRESENTATION WATCHES.

Awarded Nine Gold Medals and Four Diplomas of Honour (Highest Awards).

**FIRST PRIZE, WITH THE FREEDOM OF THE CLOCKMAKERS' COMPANY OF THE CITY OF LONDON, 1881.**

CHRONOMETERS with Kullberg's new balances and other improvements have stood First or Second *twenty-two times* at the Royal Observatory, Greenwich; and of these, three were *the best ever tried at Greenwich.*

TWO First-class Awards at Sydney Exhibition (1880): and although the watches were not intended for the competitive trial, they obtained higher marks than those of any other exhibitor.

DR. GILL, now Astronomer Royal at the Cape, wrote:—"Of the 50 chronometers used, Kullberg 488 has, on the whole, performed best. Allow me to express the great satisfaction I have had in all the chronometers of your make in the expedition to Mauritius" (Lord Crawford's Transit of Venus Expedition, 1874).

---

## SYMONS'S
## MONTHLY METEOROLOGICAL MAGAZINE.

*Monthly price 4d., or 5s. per annum, post-free.*

**THE OLDEST INDEPENDENT METEOROLOGICAL SERIAL,**
**having been established in 1866.**

*CIRCULATES IN ALL PARTS OF THE WORLD.*

Contains early notice of all new Discoveries, Theories, Phenomena, Instruments, and Publications of interest to Meteorologists, Reviews, Correspondence, and details of Climate not only in the British Isles but throughout the Empire.

LONDON:
EDWARD STANFORD, COCKSPUR STREET, S.W.
AND ALL BOOKSELLERS.

---

## HEWITT & SON,

**CHRONOMETER MAKERS**

TO THE

**RIGHT HONOURABLE THE LORDS COMMISSIONERS OF THE ADMIRALTY (since 1830).**

***344 City* Road, Islington, London, E.C.**

E. DENT & CO.,

**61 STRAND and 4 ROYAL EXCHANGE**
**(Factory: 4 HANWAY PLACE, W.),**
**LONDON.**

MANUFACTURERS OF
ASTRONOMICAL CLOCKS,
GALVANIC CHRONOGRAPHS, WATCHES,
**CHRONOMETERS, SHIPS' COMPASSES,**
TO HER MAJESTY and H.R.H. THE PRINCE OF WALES.

MAKERS OF
**THE GREAT WESTMINSTER CLOCK**
AND OF THE
NEW STANDARD CLOCK
OF
**THE ROYAL OBSERVATORY, GREENWICH,**
AND OF
**STANDARD CLOCKS AND CHRONOGRAPHS**
FOR THE
**GREENWICH, EDINBURGH. OXFORD, DUNSINK, PULKOWA,**
**BRUSSELS, GENEVA, &c. OBSERVATORIES;**

MANUFACTURERS OF
STANDARD AZIMUTH SHIPS' COMPASSES
AND
MARINE CHRONOMETERS
FOR THE
**BRITISH, AUSTRO-HUNGARIAN, ITALIAN, RUSSIAN,**
**GERMAN, SPANISH, JAPANESE, AND OTHER FOREIGN**
**AND COLONIAL GOVERNMENTS.**

---

**CATALOGUES ON APPLICATION.**

---

*61 STRAND and 4 ROYAL EXCHANGE,*
LONDON.

166 203

No. 226.] √ APRIL, 1895. [*Price* 1s.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

EDITED BY

H. H. TURNER, M.A., B.Sc., Sec. R.A.S.,
SAVILIAN PROFESSOR,
T. LEWIS, F.R.A.S.,
H. P. HOLLIS, B.A., F.R.A.S.

## CONTENTS.

Frontispiece: Portrait of the late Prof. Cayley. PAGE
Meeting of the Royal Astronomical Society on March 8 .......... 139
Meeting of the British Astronomical Association on February 27 .......... 150
Meeting of the Royal Meteorological Society on March 20 .......... 151

**Articles:—**

A Note on Stellar Parallax, with a List of Mean Parallaxes. By T. Lewis, F.R.A.S. .......... 152
Selenographical Notes. By T. G. Elger, F.R.A.S. .......... 157

**Correspondence:—**

The April Lyrids. By W. F. Denning, F.R.A.S. .......... 161
Eclipses and Chronology. By John N. Stockwell .......... 161
The Comets discovered by De Vico. By W. T. Lynn, B.A., F.R.A.S. .......... 163
The alleged Comet of 1575. By Dr. J. L. E. Dreyer, F.R.A.S., and C. Leeson Prince, F.R.A.S. .......... 164, 165
Variable Orange Stars. By T. W. Backhouse, F.R.A.S. .......... 165
The Total Lunar Eclipse of March 10. By the Rev. S. J. Johnson, F.R.A.S. 165

**Publications:—**

The Cape Catalogue of Stars for 1885·0.—Annals of the Astronomical Observatory of Harvard College: Vol. xxxii. Part i.—Annales de l'Observatoire de Paris .......... 166-169

**Notes:—**

Comet Notes.—Minor Planet Notes.—The Total Lunar Eclipse of March 10.—The Partial Solar Eclipse of March 26.—Zone Time in Australia.—Proposed Standard Time for South Africa.—Astronomy in New South Wales.—Aurora Borealis.—Death of Mr. Richard Dunkin.—Editorial.—From an Oxford Note-book .......... 170-178

**All Communications should be addressed to the EDITORS of the 'Observatory,' Royal Observatory, Greenwich, S.E.**
Annual Subscription (for the "Companion" and twelve Monthly Numbers):—13 *shillings*.

LONDON:
PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET, E.C.

## CONTENTS OF No. 225.

PAGE
Anniversary Meeting of the Royal Astronomical Society on February 8 ........ 107
Meeting of the British Astronomical Association on January 30 ................ 109
Meeting of the Royal Meteorological Society on February 20 ................ 111

**Articles:—**

Professor Cayley.—Obituary by F. W. Dyson, M.A., F.R.A.S. ................ 112
The Group Σ 1516. By Thomas Lewis, F.R.A.S. ................ 114
The Variation of Latitude ................ 114
Selenographical Notes. By T. G. Elger, F.R.A.S. ................ 117

**Correspondence:—**

Cassini and the Principal Division in Saturn's Ring. By W. T. Lynn, B.A., F.R.A.S. ................ 118
The Comet of 1525. By W. T. Lynn, B.A., F.R.A.S. ................ 120
Variable Orange Stars. By Miss E. Brown ................ 120
Planetary Spectra. By Prof. W. W. Campbell ................ 121

**Observatories:—**

Wolsingham ................ 121

**Publications:—**

The Radcliffe Observatory Catalogue for 1890.—The 'Nautical Almanac' for 1898.—L'Annuaire du Bureau des Longitudes.—Le Service Chronométrique à l'Observatoire de Genève, avec une étude des épreuves instituées dans d'autres Observatoires pour les Chronomètres de Poche.—Annuaire de l'Observatoire Royal de Belgique.—Remarkable Comets. 121–125

**Notes:—**

Comet Notes.—Minor Planet Notes.—Prof. Stockwell on Ancient Indian Eclipses.—On the Distribution of Stars in the Milky Way.—On the Relation between the Parallaxes of Stars, their Magnitudes, and their apparent Proper Motions.—The Probable Revolution of the Orbit of Phobos.—The Great Frost of February, 1895.—Zone Time System.—The Unification of Civil and Astronomical Time.—β Cassiopeiæ.—New Sadlerian Professor.—Rotation Period of the Sun.—Astronomy and the Influenza.—Total Lunar Eclipse of March 10.—Editorial Notes.—From an Oxford Note-book ................ 126–138

---

**ON SALE** (the Owner giving up Astronomical Work).—The 3-foot Common Reflector, with or without Dome, complete, in perfect order. Mirror by Sir H. Grubb. Full particulars on application to

J. GLEDHILL, Bermerside Observatory, Halifax, England.

---

**FOR SALE.**—Telescope, Refractor, on Equatorial Mounting; objective 3½ in. Cast-iron pillar and driving-clock by Cooke, York. Eyepieces 60, 100, 120, 250, and terrestrial. Price **£50** complete.

Address: Wm. GRAY, Oriental Buildings, Hull.

---

*Crown 8vo, with 40 woodcuts. Price 3s. 6d.*

A FEW CHAPTERS
IN
ASTRONOMY.
By CLAUDIUS KENNEDY, M.A.

"This gives some ingenious and intelligible explanations of various well-known phenomena which are not treated of fully in the usual text-books"—*The Observatory.*

"The idea of this book is a very good one . . . . On the whole this little work will be found of great assistance to students of mathematical astronomy, and we can strongly recommend it to their attention"—*Philosophical Magazine.*

LONDON:
OR AND FRANCIS, RED LION COURT, FLEET STREET

DIPLOMA OF HONOUR,
Highest Award, Inventions Exhibition 1885, for Marine Chronometers and
High-Class Watches.

**HENRY F. ISAAC,**
**Chronometer Maker to the Admiralty, the Indian,**
**Italian, and Colonial Governments,**

*MAKER OF ALL KINDS OF TRUSTWORTHY WATCHES.*

**10 SPENCER STREET, LONDON, E.C.**

**Eight and Two-day Chronometers, Keyless Pocket Chronometers, Repeaters, Chronographs, Deck Watches, and fine adjusted Levers, Plain and Keyless, kept in Stock.**

---

**W. WRAY, Optician,**
MANUFACTURER OF
**ASTRONOMICAL AND TERRESTRIAL TELESCOPES,**
***EQUATORIAL and other MOUNTINGS, EYEPIECES, &c., &c.,***
**MICROSCOPE OBJECTIVES AND MICROSCOPES.**
**PHOTOGRAPHIC LENSES,**
**LANTERN PROJECTION LENSES, &c., &c.**

ILLUSTRATED CATALOGUE FREE.

**LAUREL HOUSE, NORTH HILL, HIGHGATE, LONDON, N.**

---

**KENDAL & DENT,**
**WATCHMAKERS TO THE ADMIRALTY,**
**THE ROYAL ITALIAN NAVY, etc.,**
**106 CHEAPSIDE, LONDON, E.C.**
MANUFACTURERS OF
**Marine and Pocket Chronometers, Deck Watches, finely adjusted English Lever Watches, with Kew Observatory Certificates.**

***GOLD MEDAL PARIS INTERNATIONAL EXHIBITION, &c.***
**Large Illustrated Catalogue post-free on application.**

## JAMES POOLE & CO.,

**CHRONOMETER, CLOCK, & WATCH MANUFACTURERS.**

**Contractors to the Admiralty, The Council of State for India, the Crown Agents for the Colonies, the War Office, the Italian Government, &c.**

**BY SPECIAL APPOINTMENT.**

*Fine Watches and Chronometers Repaired, &c.*

*SPECIALITY:*

**CHRONOGRAPH STOP WATCHES, AS SUPPLIED TO THE ROYAL NAVY.**

**33 SPENCER STREET, CLERKENWELL, LONDON.**

DIPLOMA AND MEDAL.

**Electrical Exhibition 1892, for non-magnetizable Watches**
(*See* TIMES, March 22, 1894, *and our Book on* WATCHES).

## S. SMITH & SON, 9 Strand, London,

WATCHMAKERS TO THE ADMIRALTY.

**Largest Stock of Kew Certificated Watches in the World in Silver Cases, from £3 10s.**

OUR SUCCESSES AT KEW OBSERVATORY WITH HIGH-CLASS WATCHES.

| Year. | Total Number of Watches sent by all Makers, English & Foreign. | Number of Watches gaining Distinction and Published in the Blue Book & Reports of the Royal Society. | Our Own. |
|---|---|---|---|
| 1888 | 569 | 12 | 2 |
| 1889 | 578 | 19 | 4 |
| 1890 | 513 | 13 | 2 |
| 1891 | 709 | 17 | 2 |
| 1892 | 1044 | 17 | 2 |
| 1893 | 1521 | 18 | 2 |

AND **TWO** YEARS OUT OF THESE SIX WE HAVE HAD THE BEST WATCH OF THE YEAR.

*S. S. & SON'S 'Guide to the Purchase of a Watch' is the most complete one in existence.* 144 *pages and nearly* 300 *illustrations.*

**Particulars on application.**

## CALVER'S "COMPLETE EQUATORIAL."

(*Letters Patent.*)

This New Model embraces many radical and important improvements, making the NEWTONIAN REFLECTOR complete and perfect. **Particulars and Price-lists free.**

New edition of "HINTS ON REFLECTORS," &c. &c., **illustrated.**
By G. CALVER, F.R.A.S., Widford, Chelmsford

**Pp. xi, 361; Demy 8vo. With 2 Plates and 65 Woodcuts. Price 10s.**

# TELESCOPIC WORK FOR STARLIGHT EVENINGS.

BY

WILLIAM F. DENNING, F.R.A.S.

(Formerly President of the Liverpool Astronomical Society.)

## *EXTRACTS FROM REVIEWS.*

"As might be expected from such an experienced and enthusiastic observer as Mr. Denning, this book is thoroughly practical. He is not contented with describing the beauties of the skies, but gives invaluable information as how to see them best. To observers of limited means the book will be of the greatest assistance, both in the selection and use of their instruments. The book is full of important practical details. Every one who uses a telescope or intends to use one, of whatever dimensions, should read Mr. Denning's book."—*Nature.*

"There is a peculiar interest and fascination connected with the subject of Astronomy, which even the comparatively uneducated reader cannot but feel, and hence there exists here a field for popular presentation which is hardly equalled in any other branch of science. The present work is one of this class, and is fresh in matter, attractive and popular in style, and with its numerous illustrations cannot fail to bring pleasure and instruction to all who use it."—*American Journal of Science.*

Mr. Denning "writes as an observer of skill and experience, whilst the early chapters on the invention, history, and development of the telescope are replete with interest to all, but especially to those who are themselves astronomical observers."—*Athenæum.*

"It deserves to be read with respect and attention by every amateur astronomer; nor can the task prove anything but a pleasure to such as will genially commit themselves to the guidance of an author whose arbitrary dealings, here and there, with language impart a certain raciness to the ready and animated flow of his discourse. The want, moreover, of such an unpretending handbook is, we believe, genuinely felt. Many persons are the possessors of telescopes which they are at a loss how to employ. Intending observers cannot do better, under these circumstances, than place themselves under Mr. Denning's guidance. The book is suitably and sufficiently illustrated, in large measure from the author's original drawings."—*Saturday Review, May 23.*

"Mr. Denning is universally recognized as one of the greatest living authorities on the subject of Meteoric Astronomy. A work from his pen will therefore be read with much interest and expectation by all lovers of the sublime science, and his readers will not be disappointed. This is a very interesting and valuable work, and all telescopists should procure a copy without delay."—*Philosophical Magazine* (J. E. Gore).

"Mr. Denning is so well known as a patient observer of meteors and comets that a work from him on observational astronomy will be looked upon with special interest."—*Knowledge.*

"The illustrations are numerous and well executed and there is a fairly copious index. Mr. Denning's work will we trust have a large circulation, for it thoroughly deserves it. The book would make an admirable addition to the shelves of a lending library."—*Bristol Times and Mirror.*

"Since the appearance of Webb's '*Celestial Objects for Common Telescopes*' I much doubt if any work more useful to the amateur observer (and notably to the beginner) has appeared than '*Telescopic Work for Starlight Evenings.*' One conspicuous merit of Mr. Denning's excellent book lies in the fact that it is obviously written by a man possessing the most thorough personal familiarity with the objects he so lucidly describes."—"*F.R.A.S.*" *in English Mechanic.*

"Mr. Denning has written in a straightforward earnest fashion that must not only make many difficulties clear to his readers but inspire them with something of his own determination and enthusiasm."—*Observatory.*

"A glance at its table of contents will interest any reader of Astronomy who knows anything of the Author's ability as a practical astronomer and a ready writer on general astronomical themes."—*Sidereal Messenger.*

"Would-be purchasers of telescopes are assisted with sound advice, would-be workers with telescopes are supplied with stimulating suggestions."—*Journal of the British Astronomical Association.*

"Mr. Denning is one of the keenest, most unwearying observers in England, and the book is worthy of his reputation."—*Weekly Mail.*

LONDON:

***TAYLOR & FRANCIS***, **Red Lion Court Fleet Street.**

1891.

## WORKS PUBLISHED BY TAYLOR AND FRANCIS.

**The London, Edinburgh, and Dublin Philosophical Magazine.** Monthly. 2*s.* 6*d.*
**The Annals and Magazine of Natural History.** Monthly. 2*s.* 6*d.*
**The Observatory, Monthly Review of Astronomy.** 1*s.*
**Aelfric Society's Publications.** 15 parts. 37*s.* 6*d.*
**Aëronautics, by Brewer and Alexander.** 6*s.*
**Aitchison's (J. E. T.) Catalogue of Plants of Punjab.** 10*s.*
**Anderson's Fauna of Mergui Archipelago.** Vol. I. 30*s.*, Vol. II. 15*s.*
**Baird's (Major) Manual for Tidal Observations.** 7*s.* 6*d.*
**Belville's Manual for Thermometer.** 1*s.*
**Blakesley's Table of Hyperbolic Sines and Cosines.** 1*s.*
**Chimmo's (Capt.) Natural History of Euplectella aspergillum.** 5*s.*
**Daubeny on Volcanos.** 21*s.*
**Davis's (J. B.) Crania Britannica,** £6 10*s.* **Thesaurus Craniorum,** 20*s.*
**Denning's Telescopic Work for Starlight Evenings.** 10*s.*
**Douse's Introduction to Gothic of Ulfilas.** 10*s.* 6*d.*
**English Poetry in use at Charterhouse School.** 3*s.* 6*d.*
**Examination Papers set by Examining Board of Physicians and Surgeons.** 6*d.*
**Ditto for Diploma in Public Health.** 6*d.*
**Faraday's Experimental Researches in Chemistry and Physics.** 15*s.*
**Fauna of British India.** Edited by W. T. Blanford, F.R.S.
**Mammalia.** 20*s.* **Fishes.** 2 vols. 20*s.* each.
**Birds.** Vol. I. 20*s.* Vol. II. 15*s.* **Reptilia and Batrachia.** 20*s.*
**Moths.** Vol. I. 20*s.* Vol. II. 20*s.*
**Geological Record.** 1874-1884. 8 vols. 50*s.*
**Glaisher's Barometer Tables,** 1*s.* **Diurnal Range Tables,** 1*s.* 6*d.*
**Glaisher's Hygrometrical Tables.** 2*s.* 6*d.*
**Glaisher's Factor Tables for Fourth, Fifth, and Sixth Millions.** 20*s.* each.
**Hopkins's (E.) Geology and Terrestrial Magnetism.** 8vo. Cloth. 10*s.*
**Ditto. Illustrated Introduction to.** 8vo. Cloth. 4*s.*
**Joule's Scientific Papers.** Vol. I. 20*s.* Vol. II. 12*s.*
**Lewis's (G.) Catalogue of Japanese Coleoptera.** 2*s.* 6*d.*; on one side, 3*s.* 6*d.*
**London Hospital Pathological Catalogue.** 7*s.* 6*d.* nett.
**Manchester Lit. and Phil. Society, Memoirs.** Vols. 8 and 10. 7*s.* each.
**M'Intosh's Marine Invertebrates and Fishes of St. Andrews.** 21*s.*
**Merington's French Primer,** 2*s.* 6*d.* **English Primer,** 1*s.*
**Merington's French Pronunciation.** 2*s.* 6*d.*
**Merington's Latin First Course, with Key.** 3*s.* 6*d.*
**Olsen's (O. T.) Piscatorial Atlas.** Coloured, 52*s.* 6*d.*; uncoloured, 42*s.*
**Pascoe's Classes, Orders, &c. of the Animal Kingdom.** 3*s.* 6*d.*
**Pascoe's List of British Vertebrate Animals.** 4*s.*
**Pascoe's Student's List of British Coleoptera.** 4*s.* 6*d.*
**Phillips's Geology of Yorkshire.** 2 vols. 30*s.*
**Physical Memoirs, translated from foreign sources.** Vol. I. Part I. 4*s.*, Part II. 7*s.* 6*d.*, Part III. 6*s.*
**Reade's Origin of Mountain-Ranges.** 21*s.*
**Royal College of Surgeons Calendar.** 1*s.*
**Catalogue of Specimens illustrating the Osteology of Vertebrate Animals in Museum.** Part 3. **Aves.** 12*s.*
**Appendices 5, 6, and 7 to the Second Edition of Descriptive Catalogue of the Pathological Specimens in Museum.** 2*s.* each.
**Sharp's (Dr. D.) Staphylinidæ of Japan.** 3*s.* 6*d.*
**Smith's (R. A.) Centenary of Science in Manchester.** 10*s.*
**Taylor's Scientific Memoirs.** Ser. 1, £6 6*s.*; Ser. 2, £1 4*s.*
**Thomson's (Sir W.) Tables for facilitating Sumner's Method at Sea.** 10*s.* 6*d.* **Forms for ditto.** Sun, 1*s.* Stars, 1*s.*
**Univ. Coll. London Calendar.** 2*s.* 6*d.* **Pathological Catalogue,** Parts 1 to 3, 2*s.* each; Part 4, 1*s.* **Library Catalogue,** 3 Vols. 7*s.* 6*d.*
**Univ. Coll. Medical and Biological Catalogue.** 2*s.* 6*d.*
**Walker's (Rev. R.) Constitution of Sun.** 3*s.*
**Wheatstone's (Sir C.) Scientific Papers.** 15*s.*
**Wiogmann's Herpetologia Mexicana.** Part I. Coloured Plates. 40*s.*
**Wollaston's Notes on Lepidoptera of St Helena.** 3*s.* 6*d.*

RED LION COURT, FLEET STREET, LONDON, E.C.

**Maker to the Admiralty, the Council of State for India, and the Crown Agents for the Colonies; the Austrian, Italian, and Portuguese Governments. By Special Appointment to the King of Sweden and Norway.**

## V. KULLBERG,

105 Liverpool Road, London, N.

**CHRONOMETER AND WATCH MANUFACTURER.**

EVERY DESCRIPTION OF HIGH-CLASS KEYLESS AND ORDINARY WATCHES.

PRESENTATION WATCHES.

Awarded Nine Gold Medals and Four Diplomas of Honour (Highest Awards).

**FIRST PRIZE, WITH THE FREEDOM OF THE CLOCKMAKERS' COMPANY OF THE CITY OF LONDON, 1881.**

CHRONOMETERS with Kullberg's new balances and other improvements have stood First or Second *twenty-two times* at the Royal Observatory, Greenwich; and of these, three were *the best ever tried at Greenwich.*

Two First-class Awards at Sydney Exhibition (1889); and although the watches were not intended for the competitive trial, they obtained higher marks than those of any other exhibitor.

DR. GILL, now Astronomer Royal at the Cape, wrote:—"Of the 50 chronometers used, Kullberg 488 has, on the whole, performed best. Allow me to express the great satisfaction I have had in all the chronometers of your make in the expedition to Mauritius" (Lord Crawford's Transit of Venus Expedition, 1874).

---

## SYMONS'S
## MONTHLY METEOROLOGICAL MAGAZINE.

*Monthly price 4d., or 5s. per annum, post-free.*

**THE OLDEST INDEPENDENT METEOROLOGICAL SERIAL,**
**having been established in 1866.**

*CIRCULATES IN ALL PARTS OF THE WORLD.*

Contains early notice of all new Discoveries, Theories, Phenomena, Instruments, and Publications of interest to Meteorologists, Reviews, Correspondence, and details of Climate not only in the British Isles but throughout the Empire.

LONDON:
EDWARD STANFORD, COCKSPUR STREET, S.W.
AND ALL BOOKSELLERS.

---

## HEWITT & SON,

**CHRONOMETER MAKERS**
TO THE
**RIGHT HONOURABLE THE LORDS COMMISSIONERS OF THE ADMIRALTY (since 1830).**

***344 City* Road, Islington, London, E.C.**

E. DENT & CO.,
61 STRAND and 4 ROYAL EXCHANGE
(Factory: 4 HANWAY PLACE, W.),
LONDON.

MANUFACTURERS OF
ASTRONOMICAL CLOCKS,
GALVANIC CHRONOGRAPHS, WATCHES,
CHRONOMETERS, SHIPS' COMPASSES,
TO HER MAJESTY and H.R.H. THE PRINCE OF WALES.

MAKERS OF
**THE GREAT WESTMINSTER CLOCK**
AND OF THE
NEW STANDARD CLOCK
OF
THE ROYAL OBSERVATORY, GREENWICH,
AND OF
**STANDARD CLOCKS AND CHRONOGRAPHS**
FOR THE
GREENWICH, EDINBURGH, OXFORD, DUNSINK, PULKOWA,
BRUSSELS, GENEVA, &c. OBSERVATORIES;

MANUFACTURERS OF
STANDARD AZIMUTH SHIPS' COMPASSES
AND
MARINE CHRONOMETERS
FOR THE
BRITISH, AUSTRO-HUNGARIAN, ITALIAN, RUSSIAN,
GERMAN, SPANISH, JAPANESE, AND OTHER FOREIGN
AND COLONIAL GOVERNMENTS.

CATALOGUES ON APPLICATION.

61 STRAND and 4 ROYAL EXCHANGE
LONDON.

166

No. 232.] OCTOBER, 1895. [*Price* 1s.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

EDITED BY
H. H. TURNER, M.A., B.Sc., Sec. R.A.S.,
SAVILIAN PROFESSOR,
T. LEWIS, F.R.A.S.,
H. P. HOLLIS, B.A., F.R.A.S.

## CONTENTS.

**Articles**:- PAGE

Formulæ for Converting Measures on a Photographic Plate into R.A. and Decl. By Prof. H. H. Turner, M.A., Sec. R.A.S. .......... 351
Some Astronomical Records in ancient Chinese Books. By Prof. S. M. Russell, F.R.A.S. .......... 355
Extract from President's Address at the British Association .......... 358
Selenographical Notes. By T. G. Elger, F.R.A.S. .......... 361

**Correspondence**: –

The Visibility of the Dark Side of Venus. By W. T. Lynn, B.A., F.R.A.S. . 362
The Eclipse of A.D. 1030. By Dr. J. L. E. Dreyer .......... 363
A Proof of the Law of Gravitation. By Hans I. Kler .......... 364
Stationary Meteor-radiants. By W. H. S. Monk, F.R.A.S. .......... 365

**Publications** :—

The Longitude of Batavia. (Oudemans.) .......... 366
Hongkong Report. (Doberck.) .......... 368
Catalogue of Nebulæ. (Dreyer.) .......... 368
Stockholm Publications. (Gyldén.) .......... 368
An Elementary History of Astronomy. (Miss Taylor.) .......... 368
Total Solar Eclipse, 1893. (Schaeberle.) .......... 369

**Notes** :—

Comet Notes.—The Crossley Reflector.—The Weather in September.—Raingauges.—Sir H. Grubb's new Catalogue.—Orbit of γ Virginis.—Orbit of μ² Boötis.—Diameter of Mars.—Editorial Notes.—From an Oxford Note-book .......... 372-378

**All Communications should be addressed to the EDITORS of the 'Observatory,' Royal Observatory, Greenwich, S.E.**

Annual Subscription (for the "Companion" and twelve Monthly Numbers):—13 *shillings*.

LONDON:
PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET, E.C.

## CONTENTS OF No. 226.

Frontispiece: Portrait of the late Prof. Cayley.
Meeting of the Royal Astronomical Society on March 8................
Meeting of the British Astronomical Association on February 27 ........
Meeting of the Royal Meteorological Society on March 20..................

**Articles:—**
A Note on Stellar Parallax, with a List of Mean Parallaxes. By T. Lewi F.R.A.S. ...............................................................................
Selenographical Notes. By T. G. Elger, F.R.A.S. ............................ ..... 1

**Correspondence:—**
The April Lyrids. By W. F. Denning, F.R.A.S. .................................. 161
Eclipses and Chronology. By John N. Stockwell ............................. 161
The Comets discovered by De Vico. By W. T. Lynn, B.A., F.R.A.S. ......... 163
The alleged Comet of 1525. By Dr. J. L. E. Dreyer, F.R.A.S., and C. Leeson Prince, F.R.A.S. ............................................................ 164. 165
Variable Orange Stars. By T. W. Backhouse, F.R.A.S. .... ............ .. ... 165
The Total Lunar Eclipse of March 10. By the Rev. S. J. Johnson, F.R.A.S. 165

**Publications:—**
The Cape Catalogue of Stars for 1885·0.—Annals of the Astronomical Observatory of Harvard College: Vol. xxxii. Part i.—Annales de l'Observatoire de Paris ............................................................ 166-169

**Notes:—**
Comet Notes.—Minor Planet Notes.—The Total Lunar Eclipse of March 10. —The Partial Solar Eclipse of March 26.—Zone Time in Australia.—Proposed Standard Time for South Africa.—Astronomy in New South Wales.—Aurora Borealis.—Death of Mr. Richard Dunkin.—Editorial.—From an Oxford Note-book ............................................................ 170-175

---

**FOR SALE.**—O.G. 6-inch Cooke in brass cell, tube complete, rack focus and slide tubes with clamps; Dawes Solar, Comet, and 5 Huyghen eyepieces; Sun and Star combined diagonal, large mounted Barlow lens, &c. In perfect order and condition as new. The property of a gentleman disposing of his scientific apparatus.

LINSCOTT, Optician, Ramsgate.

---

**FOR SALE.**—Astronomical Telescope, with Object-glass of 6-in. aperture and 6-ft. focal length by Grubb, on Equatorial stand, with driving-clock by Cooke of York, R.A. Circle 7 inches, Dec. Circle 10 inches, 7 eyepieces, Barlow lens, combination Sun and Star prism by Cooke.

Apply **C. B.,** care of Editors, Royal Observatory, Greenwich, S.E.

---

**FOR SALE.**—A Sidereal Chronometer in perfect order. Its rate for the last two years can be inspected before purchase. Price **£10:0:0.**

W. J. REYNOLDS, 61 Fairholt Road, Stamford Hill, N.

---

*Crown 8vo, with 40 woodcuts. Price 3s. 6d.*

A FEW CHAPTERS
IN
ASTRONOMY.
By CLAUDIUS KENNEDY, M.A.

"This gives some ingenious and intelligible explanations of various well-known phenomena which are not treated of fully in the usual text-books."—*The Observatory.*

"The idea of this book is a very good one . . . . On the whole this little work will be found of great assistance to students of mathematical astronomy, and we can strongly recommend it to their attention." *Philosophical Magazine*

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

DIPLOMA OF HONOUR,
Highest Award, Inventions Exhibition, 1885, for Marine Chronometers and High-Class Watches.

**HENRY P. ISAAC,**
**Chronometer Maker to the Admiralty, the Indian, Italian, and Colonial Governments,**

*MAKER OF ALL KINDS OF TRUSTWORTHY WATCHES.*

**10 SPENCER STREET, LONDON, E.C.**

**Eight and Two-day Chronometers, Keyless Pocket Chronometers, Repeaters, Chronographs, Deck Watches, and fine adjusted Levers, Plain and Keyless, kept in Stock.**

---

**W. WRAY, Optician,**

MANUFACTURER OF

**ASTRONOMICAL AND TERRESTRIAL TELESCOPES,**
***EQUATORIAL and other MOUNTINGS, EYEPIECES, &c., &c.,***
MICROSCOPE OBJECTIVES AND MICROSCOPES,
**PHOTOGRAPHIC LENSES,**
LANTERN PROJECTION LENSES, &c., &c.

ILLUSTRATED CATALOGUE FREE.

LAUREL HOUSE, NORTH HILL, HIGHGATE, LONDON, N.

---

**KENDAL & DENT,**

WATCHMAKERS TO THE ADMIRALTY,
THE ROYAL ITALIAN NAVY, etc.,

**106 CHEAPSIDE, LONDON, E.C.**

MANUFACTURERS OF

**Marine and Pocket Chronometers, Deck Watches, finely adjusted English Lever Watches, with Kew Observatory Certificates.**

*GOLD MEDAL PARIS INTERNATIONAL EXHIBITION, &c.*
**Large Illustrated Catalogue post-free on application.**

## JAMES POOLE & CO.,

**CHRONOMETER, CLOCK, & WATCH MANUFACTURERS,**

**Contractors to the Admiralty, The Council of State for India, the Crown Agents for the Colonies, the War Office, the Italian Government, &c.**

**BY SPECIAL APPOINTMENT.**

*Fine Watches and Chronometers Repaired, &c.*

*SPECIALITY:*

**CHRONOGRAPH STOP WATCHES, AS SUPPLIED TO THE ROYAL NAVY.**

**33 SPENCER STREET, CLERKENWELL, LONDON.**

DIPLOMA AND MEDAL,
**Electrical Exhibition 1892, for non-magnetizable Watches**
(*See* TIMES, March 22, 1894, *and our Book on* WATCHES).

**S. SMITH & SON, 9 Strand, London,**
WATCHMAKERS TO THE ADMIRALTY.
**Largest Stock of Kew Certificated Watches in the World in Silver Cases, from £8 10s.**

OUR SUCCESSES AT KEW OBSERVATORY WITH HIGH-CLASS WATCHES.

| Year. | Total Number of Watches sent by all Makers, English & Foreign. | Number of Watches gaining Distinction and Published in the Blue Book & Reports of the Royal Society. | Our Own. |
|---|---|---|---|
| 1888 | 569 | 12 | 2 |
| 1889 | 528 | 19 | 4 |
| 1890 | 513 | 13 | 2 |
| 1891 | 709 | 17 | 2 |
| 1892 | 1044 | 17 | 2 |
| 1893 | 1521 | 18 | 2 |

AND **TWO** YEARS OUT OF THESE SIX WE HAVE HAD THE BEST WATCH OF THE YEAR.

*S. S. & SON'S 'Guide to the Purchase of a Watch' is the most complete one in existence. 141 pages and nearly 300 illustrations.*

**Particulars on application.**

**CALVER'S "COMPLETE EQUATORIAL."**
(*Letters Patent.*)

This New Model embraces many radical and important improvements, making the NEWTONIAN REFLECTOR complete and perfect. Particulars and Price-lists free.

New edition of "HINTS ON REFLECTORS," &c. &c., illustrated.
By G. CALVER, F.R.A.S., Widford, Chelmsford.

**Pp. xi, 361 ; Demy 8vo. With 2 Plates and 65 Woodcuts. Price 10s.**

# TELESCOPIC WORK FOR STARLIGHT EVENINGS.

BY

WILLIAM F. DENNING, F.R.A.S.

(Formerly President of the Liverpool Astronomical Society.)

*EXTRACTS FROM REVIEWS.*

**"As might be expected from such an experienced and enthusiastic observer as Mr. Denning, this book is thoroughly practical. He is not contented with describing the beauties of the skies, but gives invaluable information as how to see them best. To observers of limited means the book will be of the greatest assistance, both in the selection and use of their instruments. The book is full of important practical details. Every one who uses a telescope or intends to use one, of whatever dimensions, should read Mr. Denning's book."**—*Nature.*

**"There is a peculiar interest and fascination connected with the subject of Astronomy, which even the comparatively uneducated reader cannot but feel, and hence there exists here a field for popular presentation which is hardly equalled in any other branch of science. The present work is one of this class, and is fresh in matter, attractive and popular in style, and with its numerous illustrations cannot fail to bring pleasure and instruction to all who use it."**—*American Journal of Science.*

**Mr. Denning "writes as an observer of skill and experience, whilst the early chapters on the invention, history, and development of the telescope are replete with interest to all, but especially to those who are themselves astronomical observers."**—*Athenæum.*

**"It deserves to be read with respect and attention by every amateur astronomer; nor can the task prove anything but a pleasure to such as will genially commit themselves to the guidance of an author whose arbitrary dealings, here and there, with language impart a certain raciness to the ready and animated flow of his discourse. The want, moreover, of such an unpretending handbook is, we believe, genuinely felt. Many persons are the possessors of telescopes which they are at a loss how to employ. Intending observers cannot do better, under these circumstances, than place themselves under Mr. Denning's guidance. The book is suitably and sufficiently illustrated, in large measure from the author's original drawings."**—*Saturday Review, May 23.*

**"Mr. Denning is universally recognized as one of the greatest living authorities on the subject of Meteoric Astronomy. A work from his pen will therefore be read with much interest and expectation by all lovers of the sublime science, and his readers will not be disappointed. This is a very interesting and valuable work, and all telescopists should procure a copy without delay."**—*Philosophical Magazine* **(J. E. Gore).**

**"Mr. Denning is so well known as a patient observer of meteors and comets that a work from him on observational astronomy will be looked upon with special interest."** *Knowledge.*

**"The illustrations are numerous and well executed and there is a fairly copious index. Mr. Denning's work will we trust have a large circulation, for it thoroughly deserves it. The book would make an admirable addition to the shelves of a lending library."**—*Bristol Times and Mirror.*

**"Since the appearance of Webb's '*Celestial Objects for Common Telescopes*' I much doubt if any work more useful to the amateur observer (and notably to the beginner) has appeared than '*Telescopic Work for Starlight Evenings.*' One conspicuous merit of Mr. Denning's excellent book lies in the fact that it is obviously written by a man possessing the most thorough personal familiarity with the objects he so lucidly describes."**—*"F.R.A.S." in English Mechanic.*

**"Mr. Denning has written in a straightforward earnest fashion that must not only make many difficulties clear to his readers but inspire them with something of his own determination and enthusiasm."** *Observatory.*

**"A glance at its table of contents will interest any reader of Astronomy who knows anything of the Author's ability as a practical astronomer and a ready writer on general astronomical themes."** –*Sidereal Messenger.*

**"Would-be purchasers of telescopes are assisted with sound advice, would-be workers with telescopes are supplied with stimulating suggestions."**—*Journal of the British Astronomical Association.*

**"Mr. Denning is one of the keenest, most unwearying observers in England, and the book is worthy of his reputation."**—*Weekly Mail.*

LONDON:

**TAYLOR & FRANCIS, Red Lion Court Fleet Street.**

1891.

## WORKS PUBLISHED BY TAYLOR AND FRANCIS.

**The London, Edinburgh, and Dublin Philosophical Magazine.** Monthly. 2*s.* 6*d.*
**The Annals and Magazine of Natural History.** Monthly. 2*s.* 6*d.*
**The Observatory, Monthly Review of Astronomy.** 1*s.*
**Aelfric Society's Publications.** 15 parts. 37*s.* 6*d.*
**Aëronautics, by Brewer and Alexander.** 6*s.*
**Anderson's Fauna of Mergui Archipelago.** Vol. I. 30*s.*, Vol. II. 15*s.*
**Baird's (Major) Manual for Tidal Observations.** 7*s.* 6*d.*
**Belville's Manual for Thermometer.** 1*s.*
**Blakesley's Table of Hyperbolic Sines and Cosines.** 1*s.*
**Chimmo's (Capt.) Natural History of Euplectella aspergillum.** 5*s.*
**Daubeny on Volcanos.** 21*s.*
**Davis's (J. B.) Crania Britannica,** £6 10*s.* **Thesaurus Craniorum,** 20*s.*
**Denning's Telescopic Work for Starlight Evenings.** 10*s.*
**Douse's Introduction to Gothic of Ulfilas.** 10*s.* 6*d.*
**English Poetry in use at Charterhouse School.** 3*s.* 6*d.*
**Examination Papers set by Examining Board of Physicians and Surgeons.** 6*d.*
**Ditto for Diploma in Public Health.** 6*d.*
**Faraday's Experimental Researches in Chemistry and Physics.** 15*s.*
**Fauna of British India.** Edited by W. T. Blanford, F.R.S.
**Mammalia.** 20*s.* **Fishes.** 2 vols. 20*s.* each.
**Birds.** Vol. I. 20*s.* Vol. II. 15*s.* **Reptilia and Batrachia.** 20*s.*
**Moths.** Vol. I. 20*s.* Vol. II. 20*s.* Vol. III. 20*s.*
**Geological Record.** 1874–1884. 8 vols. 50*s.*
**Glaisher's Barometer Tables,** 1*s.* **Diurnal Range Tables,** 1*s.* 6*d.*
**Glaisher's Hygrometrical Tables.** 2*s.* 6*d.*
**Glaisher's Factor Tables for Fourth, Fifth, and Sixth Millions.** 20*s.* each.
**Hopkins's (E.) Geology and Terrestrial Magnetism.** 8vo. Cloth. 16*s.*
**Ditto. Illustrated Introduction to.** 8vo. Cloth. 4*s.*
**Joule's Scientific Papers.** Vol. I. 20*s.* Vol. II. 12*s.*
**Kennedy, C. A few Chapters in Astronomy.** 3*s.* 6*d.*
**Lehfeldt, R. A. A List of chief Memoirs on Physics of Matter.** 2*s.* 6*d.*
**Lewis's (G.) Catalogue of Japanese Coleoptera.** 2*s.* 6*d.*; on one side, 3*s.* 6*d.*
**London Hospital Pathological Catalogue.** 7*s.* 6*d.* nett.
**M'Intosh's Marine Invertebrates and Fishes of St. Andrews.** 21*s.*
**Merington's French Primer,** 2*s.* 6*d.* **English Primer,** 1*s.*
**Merington's French Pronunciation.** 2*s.* 6*d.*
**Merington's Latin First Course, with Key.** 3*s.* 6*d.*
**Pascoe's Classes, Orders, &c. of the Animal Kingdom.** 3*s.* 6*d.*
**Pascoe's List of British Vertebrate Animals.** 4*s.*
**Pascoe's Student's List of British Coleoptera.** 4*s.* 6*d.*
**Phillips's Geology of Yorkshire.** 2 vols. 30*s.*
**Physical Proceedings and Abstracts.** Monthly. 2*s.* 6*d.*
**Physical Memoirs, translated from foreign sources.** Vol. I. Part I. 4*s.*, Part II. 7*s.* 6*d.*, Part III. 6*s.*
**Reade's Origin of Mountain-Ranges.** 21*s.*
**Royal College of Surgeons Calendar.** 1*s.*
**Catalogue of Specimens illustrating the Osteology of Vertebrate Animals in Museum.** Part 3. **Aves.** 12*s.*
**Catalogue of Teratological Series.** 5*s.*
**Appendices 5, 6, 7, and 8 to the Second Edition of Descriptive Catalogue of the Pathological Specimens in Museum.** 2*s.* each.
**Examination Papers for Diploma of Fellow and Licence in Dental Surgery.** 6*d.*
**Sharp's (Dr. D.) Staphylinidæ of Japan.** 3*s.* 6*d.*
**Taylor's Scientific Memoirs.** Ser. 1. £6 6*s.*; Ser. 2. £1 4*s.*
**Thomson's (Sir W.) Tables for facilitating Sumner's Method at Sea.** 10*s.* 6*d.* **Forms for ditto.** Sun, 1*s.* Stars, 1*s.*
**Univ. Coll. London Calendar,** 2*s.* 6*d.* **Pathological Catalogue,** Parts 1 to 3. 2*s.* each; Part 4. 1*s.* **Library Catalogue,** 3 Vols. 7*s.* 6*d.*
**Univ. Coll. Medical and Biological Catalogue.** 2*s.* 6*d.*
**Wheatstone's (Sir C.) Scientific Papers.** 15*s.*
**Wollaston's Notes on Lepidoptera of St. Helena.** 3*s.* 6*d.*

*RED LION COURT, FLEET STREET, LONDON, E.C.*

Maker to the Admiralty, the Council of State for India, and the Crown Agents for the Colonies; the Austrian, Italian, and Portuguese Governments. By Special Appointment to the King of Sweden and Norway.

# V. KULLBERG,

105 Liverpool Road, London, N.

**CHRONOMETER AND WATCH MANUFACTURER.**

EVERY DESCRIPTION OF HIGH-CLASS KEYLESS AND ORDINARY WATCHES.

PRESENTATION WATCHES.

Awarded Nine Gold Medals and Four Diplomas of Honour (Highest Awards).

**FIRST PRIZE, WITH THE FREEDOM OF THE CLOCKMAKERS' COMPANY OF THE CITY OF LONDON, 1881.**

CHRONOMETERS with Kullberg's new balances and other improvements have stood First or Second *twenty-two times* at the Royal Observatory, Greenwich; and of these, three were *the best ever tried at Greenwich.*

Two First-class Awards at Sydney Exhibition (1880); and although the watches were not intended for the competitive trial, they obtained higher marks than those of any other exhibitor.

DR. GILL, now Astronomer Royal at the Cape, wrote:—"Of the 50 chronometers used, Kullberg 488 has, on the whole, performed best. Allow me to express the great satisfaction I have had in all the chronometers of your make in the expedition to Mauritius" (Lord Crawford's Transit of Venus Expedition, 1874).

---

## SYMONS'S
## MONTHLY METEOROLOGICAL MAGAZINE.

*Monthly price 4d., or 5s. per annum, post-free.*

**THE OLDEST INDEPENDENT METEOROLOGICAL SERIAL, having been established in 1866.**

*CIRCULATES IN ALL PARTS OF THE WORLD.*

Contains early notice of all new Discoveries, Theories, Phenomena, Instruments, and Publications of interest to Meteorologists, Reviews, Correspondence, and details of Climate not only in the British Isles but throughout the Empire.

LONDON:
EDWARD STANFORD, COCKSPUR STREET, S.W.
AND ALL BOOKSELLERS.

---

## HEWITT & SON,

**CHRONOMETER MAKERS**

TO THE

RIGHT HONOURABLE THE LORDS COMMISSIONERS OF THE ADMIRALTY (since 1830).

***344 City Road, Islington, London, E.C.***

E. DENT & CO.,
**61 STRAND and 4 ROYAL EXCHANGE**
**(Factory: 4 HANWAY PLACE, W.),**
**LONDON.**

MANUFACTURERS OF
ASTRONOMICAL CLOCKS,
GALVANIC CHRONOGRAPHS, WATCHES,
**CHRONOMETERS, SHIPS' COMPASSES,**
TO HER MAJESTY and H.R.H. THE PRINCE OF WALES.

MAKERS OF
**THE GREAT WESTMINSTER CLOCK**
AND OF THE
NEW STANDARD CLOCK
OF
THE ROYAL OBSERVATORY, GREENWICH,
AND OF
**STANDARD CLOCKS AND CHRONOGRAPHS**
FOR THE
GREENWICH, EDINBURGH, OXFORD, DUNSINK, PULKOWA,
BRUSSELS, GENEVA, &c. OBSERVATORIES;

MANUFACTURERS OF
STANDARD AZIMUTH SHIPS' COMPASSES
AND
MARINE CHRONOMETERS
FOR THE
BRITISH, AUSTRO-HUNGARIAN, ITALIAN, RUSSIAN,
GERMAN, SPANISH, JAPANESE, AND OTHER FOREIGN
AND COLONIAL GOVERNMENTS.

**CATALOGUES ON APPLICATION.**

*61 STRAND and 4 ROYAL EXCHANGE,*
LONDON.

J 116

No. 233.] NOVEMBER, 1895. [*Price* 1s.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

EDITED BY

H. H. TURNER, M.A., B.Sc., Sec. R.A.S.,
SAVILIAN PROFESSOR,
T. LEWIS, F.R.A.S.,
H. P. HOLLIS, B.A., F.R.A.S.

CONTENTS.

**Articles:—**

PAGE
The Dimensions of Saturn's Ring. By T. Lewis, F.R.A.S. ................. 379
On the Probable Errors of Meridian Observations in Declination ............ 386
Selenographical Notes. By T. G. Elger, F.R.A.S. ................. 389

**Correspondence:—**

On the Number of Figures necessary in Reductions. By E. J. Stone, F.R.A.S. 391
A new Method of Determining Velocity in the Line of Sight. By Herr Artémie Orbinsky, and Prof. Edwin B. Frost, F.R.A.S. ............ 393, 394
Discovery of Small Planets: small Perihelion Distances of a few. By W. T. Lynn, B.A., F.R.A.S. ................. 395
Daylight Occultation of B.A.C. 6127. By John Tebbutt, F.R.A.S. ......... 396

**Observatories:—**

Cape.—Melbourne ................. 396, 397

**Publications:—**

Mr. Stanley on the Nebular Theory.—The Herschels and Modern Astronomy.—A Lunar Atlas.—Double-Star Measures ................. 399–402

**Notes:—**

Comet Notes.—Minor Planet Notes.—The Constitution of Saturn's Rings.—$\alpha$ Centauri.—Death of E. von Rebeur-Paschwitz.—Absolute Dimensions, &c., of Stellar Systems.—The Weather.—Editorial Notes.—From an Oxford Note-book ................. 403–410

**All Communications should be addressed to the EDITORS of the 'Observatory,' Royal Observatory, Greenwich, S.E.**

Annual Subscription (for the "Companion" and twelve Monthly Numbers):—13 *shillings*.

LONDON:
PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET, E.C.

# CONTENTS OF No. 227.

PAGE
Meeting of the Royal Astronomical Society on April 10 ........................ 179
Meeting of the British Astronomical Association on March 27 .................... 188
Meeting of the Royal Meteorological Society on April 17 ............................ 189

**Articles:—**

The Solar Eclipse of 1896 August 8. By Prof. H. GEELMUYDEN ............... 190
Some anomalous Sidereal Spectra. By Miss A. M. CLERKE ..................... 193
Selenographical Notes. By T. G. ELGER, F.R.A.S. ........................................ 196

**Correspondence:—**

Eclipses and Chronology. By W. T. LYNN, B.A., F.R.A.S. ....................... 197
On Heis's T Radiants. By Dr. W. DOBERCK ................................................ 199
Comet I. 1894. By W. F. DENNING, F.R.A.S. ................................................ 199
Variable Orange Stars. By Miss E. BROWN and Capt. WM. NOBLE, F.R.A.S. 200

**Observatories:—**

Stonyhurst ............................................................................................. 202

**Publications:—**

The Elements of the Four Inner Planets and the Fundamental Constants of Astronomy.—Smithsonian Geographical Tables ........................ 202–205

**Notes:—**

An Explanation.—Comet Notes.—Minor Planet Notes.—The Diameter of Neptune.—A new Form of Zenith Telescope.—The Application of Instrumental Corrections to Transit Observations.—4 Aquarii (Σ 2729).—Astronomical Society of Wales.—Legal Time in Canada.—Zone-Time System.—A large Reflector for the Lick Observatory.—Editorial Notes.—From an Oxford Note-book ............................................. 206–214

---

**FOR SALE.**—O.G. 6-INCH COOKE in brass cell, tube complete, rack focus and slide tubes with clamps; Dawes Solar, Comet, and 5 Huyghen eyepieces; Sun and Star combined diagonal, large mounted Barlow lens, &c. In perfect order and condition as new. The property of a gentleman disposing of his scientific apparatus.

LINSCOTT, Optician, Ramsgate.

---

**FOR SALE.**—ASTRONOMICAL TELESCOPE, with Object-glass of 6-in. aperture and 6-ft. focal length by Grubb, on Equatorial stand, with driving-clock by Cooke of York, R.A. Circle 7 inches, Dec. Circle 10 inches, 7 eyepieces, Barlow lens, combination Sun and Star prism by Cooke.

Apply **C. B.,** care of Editors, Royal Observatory, Greenwich, S.E.

---

**FOR SALE.**—A SIDEREAL CHRONOMETER in perfect order. Its rate for the last two years can be inspected before purchase. Price **£10 : 0 : 0.**

W. J. REYNOLDS, 61 Fairholt Road, Stamford Hill, N.

---

**FOR SALE.**—A COMPLETELY MOUNTED EQUATORIAL TELESCOPE, in perfect working order, 8 inches aperture, by COOKE & SONS, with driving-clock, the last telescope of the late Rev. W. R. DAWES. 10 Huyghenian eyepieces, 2 Kellner comet eyepieces, Barlow lens, Dawes's Solar *eyepiece*, Parallel-wire micrometer, Double Solar prism, all formerly *belonging* to the late Mr. DAWES.

Apply GEO. HUNT, 25 Alleyn Park, West Dulwich, S.E.

DIPLOMA OF HONOUR,
Highest Award, Inventions Exhibition, 1885, for Marine Chronometers and High-Class Watches.

**HENRY P. ISAAC,**
**Chronometer Maker to the Admiralty, the Indian, Italian, and Colonial Governments,**

*MAKER OF ALL KINDS OF TRUSTWORTHY WATCHES.*

10 SPENCER STREET, LONDON, E.C.

**Eight and Two-day Chronometers, Keyless Pocket Chronometers, Repeaters, Chronographs, Deck Watches, and fine adjusted Levers, Plain and Keyless, kept in Stock.**

---

**W. WRAY, Optician,**

MANUFACTURER OF

**ASTRONOMICAL AND TERRESTRIAL TELESCOPES,**
***EQUATORIAL and other MOUNTINGS, EYEPIECES, &c., &c.,***
**MICROSCOPE OBJECTIVES AND MICROSCOPES.**
**PHOTOGRAPHIC LENSES,**
**LANTERN PROJECTION LENSES, &c., &c.**

ILLUSTRATED CATALOGUE FREE.

LAUREL HOUSE, NORTH HILL, HIGHGATE, LONDON, N.

---

**KENDAL & DENT,**

WATCHMAKERS TO THE ADMIRALTY,
THE ROYAL ITALIAN NAVY, etc.,
106 CHEAPSIDE, LONDON, E.C.

MANUFACTURERS OF

**Marine and Pocket Chronometers, Deck Watches, finely adjusted English Lever Watches, with Kew Observatory Certificates.**

*GOLD MEDAL PARIS INTERNATIONAL EXHIBITION, &c.*
*Large Illustrated* Catalogue post-free on application.

## JAMES POOLE & CO.,

CHRONOMETER, CLOCK, & WATCH MANUFACTURERS.

Contractors to the Admiralty, The Council of State for India, the Crown Agents for the Colonies, the War Office, the Italian Government, &c.

BY SPECIAL APPOINTMENT.

*Fine Watches and Chronometers Repaired, &c.*

*SPECIALITY:*

**CHRONOGRAPH STOP WATCHES, AS SUPPLIED TO THE ROYAL NAVY.**

33 SPENCER STREET, CLERKENWELL, LONDON.

---

DIPLOMA AND MEDAL.

**Electrical Exhibition 1892, for non-magnetizable Watches**

(See TIMES, March 22, 1894, *and our Book on* WATCHES).

## S. SMITH & SON, 9 Strand, London,

WATCHMAKERS TO THE ADMIRALTY.

**Largest Stock of Kew Certificated Watches in the World in Silver Cases, from £8 10s.**

**Class "A" 8 up to 81·7 marks.**

OUR SUCCESSES AT KEW OBSERVATORY WITH HIGH-CLASS WATCHES.

| Year. | Total Number of Watches sent by all Makers, English & Foreign. | Number of Watches gaining Distinction and Published in the Blue Book & Reports of the Royal Society. | Our Own. |
|---|---|---|---|
| 1888 | 569 | 12 | 2 |
| 1889 | 598 | 19 | 4 |
| 1890 | 513 | 13 | 3 |
| 1891 | 709 | 17 | 2 |
| 1892 | 1044 | 17 | 3 |
| 1893 | 1521 | 18 | 2 |
| 1894 | 737 | 14 | 4 |

AND THREE YEARS OUT OF THESE SEVEN WE HAVE HAD THE BEST WATCH OF THE YEAR.

*S. S. & SON'S 'Guide to the Purchase of a Watch' is the most complete one in existence, 144 pages and nearly 300 illustrations.*

**Particulars on application.**

---

## CALVER'S "COMPLETE EQUATORIAL."

*(Letters Patent.)*

This New Model embraces many radical and important improvements, making the NEWTONIAN REFLECTOR complete and perfect. Particulars and Price-lists free.

New edition of "HINTS ON REFLECTORS," &c. &c., illustrated.

By G. CALVER, F.R.A.S., Widford, Chelmsford.

Pp. xi, 361 ; Demy 8vo. With 2 Plates and 65 Woodcuts. Price 10*s.*

# TELESCOPIC WORK FOR STARLIGHT EVENINGS.

BY

WILLIAM F. DENNING, F.R.A.S.

(Formerly President of the Liverpool Astronomical Society.)

## *EXTRACTS FROM REVIEWS.*

"As might be expected from such an experienced and enthusiastic observer as Mr. Denning, this book is thoroughly practical. He is not contented with describing the beauties of the skies, but gives invaluable information as how to see them best. To observers of limited means the book will be of the greatest assistance, both in the selection and use of their instruments. The book is full of important practical details. Every one who uses a telescope or intends to use one, of whatever dimensions, should read Mr. Denning's book."—*Nature.*

"There is a peculiar interest and fascination connected with the subject of Astronomy, which even the comparatively uneducated reader cannot but feel, and hence there exists here a field for popular presentation which is hardly equalled in any other branch of science. The present work is one of this class, and is fresh in matter, attractive and popular in style, and with its numerous illustrations cannot fail to bring pleasure and instruction to all who use it."—*American Journal of Science.*

Mr. Denning "writes as an observer of skill and experience, whilst the early chapters on the invention, history, and development of the telescope are replete with interest to all, but especially to those who are themselves astronomical observers."—*Athenæum.*

"It deserves to be read with respect and attention by every amateur astronomer; nor can the task prove anything but a pleasure to such as will genially commit themselves to the guidance of an author whose arbitrary dealings, here and there, with language impart a certain raciness to the ready and animated flow of his discourse. The want, moreover, of such an unpretending handbook is, we believe, genuinely felt. Many persons are the possessors of telescopes which they are at a loss how to employ. Intending observers cannot do better, under these circumstances, than place themselves under Mr. Denning's guidance. The book is suitably and sufficiently illustrated, in large measure from the author's original drawings."—*Saturday Review, May* 23.

"Mr. Denning is universally recognized as one of the greatest living authorities on the subject of Meteoric Astronomy. A work from his pen will therefore be read with much interest and expectation by all lovers of the sublime science, and his readers will not be disappointed. This is a very interesting and valuable work, and all telescopists should procure a copy without delay."—*Philosophical Magazine* (J. E. Gore).

"Mr. Denning is so well known as a patient observer of meteors and comets that a work from him on observational astronomy will be looked upon with special interest."—*Knowledge.*

"The illustrations are numerous and well executed and there is a fairly copious index. Mr. Denning's work will we trust have a large circulation, for it thoroughly deserves it. The book would make an admirable addition to the shelves of a lending library."—*Bristol Times and Mirror.*

"Since the appearance of Webb's '*Celestial Objects for Common Telescopes*' I much doubt if any work more useful to the amateur observer (and notably to the beginner) has appeared than '*Telescopic Work for Starlight Evenings.*' One conspicuous merit of Mr. Denning's excellent book lies in the fact that it is obviously written by a man possessing the most thorough personal familiarity with the objects he so lucidly describes."—"*F.R.A.S.*" *in English Mechanic.*

"Mr. Denning has written in a straightforward earnest fashion that must not only make many difficulties clear to his readers but inspire them with something of his own determination and enthusiasm."—*Observatory.*

"A glance at its table of contents will interest any reader of Astronomy who knows anything of the Author's ability as a practical astronomer and a ready writer on general astronomical themes"—*Sidereal Messenger.*

"Would-be purchasers of telescopes are assisted with sound advice, would-be workers with telescopes are supplied with stimulating suggestions."—*Journal of the British Astronomical Association.*

"Mr. Denning is one of the keenest, most unwearying observers in England, and the book is worthy of his reputation."—*Weekly Mail.*

LONDON:

***TAYLOR & FRANCIS,*** **Red Lion Court Fleet Street.**

1891.

## WORKS PUBLISHED BY TAYLOR AND FRANCIS.

**The London, Edinburgh, and Dublin Philosophical Magazine.** Monthly. 2*s*. 6*d*.
**The Annals and Magazine of Natural History.** Monthly. 2*s*. 6*d*.
**The Observatory, Monthly Review of Astronomy.** 1*s*.
**Aelfric Society's Publications.** 15 parts. 37*s*. 6*d*.
**Aëronautics, by Brewer and Alexander.** 6*s*.
**Anderson's Fauna of Mergui Archipelago.** Vol. I. 30*s*., Vol. II. 15*s*.
**Baird's (Major) Manual for Tidal Observations.** 7*s*. 6*d*.
**Belville's Manual for Thermometer.** 1*s*.
**Blakesley's Table of Hyperbolic Sines and Cosines.** 1*s*.
**Chimmo's (Capt.) Natural History of Euplectella aspergillum.** 5*s*.
**Daubeny on Volcanos.** 21*s*.
**Davis's (J. B.) Crania Britannica,** £6 10*s*. **Thesaurus Craniorum,** 20*s*.
**Denning's Telescopic Work for Starlight Evenings.** 10*s*.
**Douse's Introduction to Gothic of Ulfilas.** 10*s*. 6*d*.
**English Poetry in use at Charterhouse School.** 3*s*. 6*d*.
**Examination Papers set by Examining Board of Physicians and Surgeons.** 6*d*.
  **Ditto for Diploma in Public Health.** 6*d*.
**Faraday's Experimental Researches in Chemistry and Physics.** 15*s*.
**Fauna of British India.** Edited by W. T. BLANFORD, F.R.S.
  **Mammalia.** 20*s*.   **Fishes.** 2 vols. 20*s*. each.
  **Birds.** Vol. I. 20*s*. Vol. II. 15*s*.   **Reptilia and Batrachia.** 20*s*.
  **Moths.** Vol. I. 20*s*. Vol. II. 20*s*. Vol. III. 20*s*.
**Geological Record.** 1874–1884. 8 vols. 50*s*.
**Glaisher's Barometer Tables,** 1*s*. **Diurnal Range Tables,** 1*s*. 6*d*.
**Glaisher's Hygrometrical Tables.** 2*s*. 6*d*.
**Glaisher's Factor Tables for Fourth, Fifth, and Sixth Millions.** 20*s*. each.
**Hopkins's (E.) Geology and Terrestrial Magnetism.** 8vo. Cloth. 16*s*.
  **Ditto. Illustrated Introduction to.** 8vo. Cloth. 4*s*.
**Joule's Scientific Papers.** Vol. I. 20*s*. Vol. II. 12*s*.
**Kennedy. C. A few Chapters in Astronomy.** 3*s*. 6*d*.
**Lehfeldt, R. A. A List of chief Memoirs on Physics of Matter.** 2*s*. 6*d*.
**Lewis's (G.) Catalogue of Japanese Coleoptera.** 2*s*. 6*d*.; on one side, 3*s* 6*d*.
**London Hospital Pathological Catalogue.** 7*s*. 6*d*. nett.
**M'Intosh's Marine Invertebrates and Fishes of St. Andrews.** 21*s*.
**Merington's French Primer,** 2*s*. 6*d*. **English Primer,** 1*s*.
**Merington's French Pronunciation.** 2*s*. 6*d*.
**Merington's Latin First Course, with Key.** 3*s*. 6*d*.
**Pascoe's Classes, Orders, &c. of the Animal Kingdom.** 3*s*. 6*d*.
**Pascoe's List of British Vertebrate Animals.** 4*s*.
**Pascoe's Student's List of British Coleoptera.** 4*s*. 6*d*.
**Phillips's Geology of Yorkshire.** 2 vols. 30*s*.
**Physical Proceedings and Abstracts.** Monthly. 2*s*. 6*d*.
**Physical Memoirs, translated from foreign sources.** Vol. I. Part I. 4*s*., Part II. 7*s*. 6*d*., Part III. 6*s*.
**Reade's Origin of Mountain-Ranges.** 21*s*.
**Royal College of Surgeons Calendar.** 1*s*.
  **Catalogue of Specimens illustrating the Osteology of Vertebrate Animals in Museum.** Part 3. **Aves.** 12*s*.
  **Catalogue of Teratological Series.** 5*s*.
  **Appendices 5, 6, 7, and 8 to the Second Edition of Descriptive Catalogue of the Pathological Specimens in Museum.** 2*s*. each.
  **Examination Papers for Diploma of Fellow and Licence in Dental Surgery.** 6*d*.
**Sharp's (Dr. D.) Staphylinidæ of Japan.** 3*s*. 6*d*.
**Taylor's Scientific Memoirs.** Ser. 1. £6 6*s*.; Ser. 2, £1 4*s*.
**Thomson's (Sir W.) Tables for facilitating Sumner's Method at Sea.** 10*s*. 6*d*. **Forms for ditto.** SUN, 1*s*. STARS, 1*s*.
***Univ. Coll.* London Calendar,** 2*s*. 6*d*. **Pathological Catalogue,** Parts 1 to 3, 2*s*. each; Part 4. 1*s*. **Library Catalogue,** 3 Vols. 7*s*. 6*d*.
***Univ. Coll.* Medical and Biological Catalogue.** 2*s*. 6*d*.
***Wheatstone's* (Sir C.) Scientific Papers.** 15*s*.
**Wolle[illegible] Notes on Lepidoptera of St. Helena.** 3*s*. 6*d*.

**Maker to the Admiralty, the Council of State for India, and the Crown Agents for the Colonies; the Austrian, Italian, and Portuguese Governments. By Special Appointment to the King of Sweden and Norway.**

# V. KULLBERG,

**105 Liverpool Road, London, N.**

**CHRONOMETER AND WATCH MANUFACTURER.**

**EVERY DESCRIPTION OF HIGH-CLASS KEYLESS AND ORDINARY WATCHES.**

**PRESENTATION WATCHES.**

Awarded Nine Gold Medals and Four Diplomas of Honour (Highest Awards).

**FIRST PRIZE, WITH THE FREEDOM OF THE CLOCKMAKERS' COMPANY OF THE CITY OF LONDON, 1881.**

CHRONOMETERS with Kullberg's new balances and other improvements have stood First or Second *twenty-two times* at the Royal Observatory, Greenwich; and of these, three were *the best ever tried at Greenwich.*

TWO First-class Awards at Sydney Exhibition (1880): and although the watches were not intended for the competitive trial, they obtained higher marks than those of any other exhibitor.

DR. GILL, now Astronomer Royal at the Cape, wrote:—"Of the 50 chronometers used, Kullberg 488 has, on the whole, performed best. Allow me to express the great satisfaction I have had in all the chronometers of your make in the expedition to Mauritius" (Lord Crawford's Transit of Venus Expedition, 1874).

---

SYMONS'S

# MONTHLY METEOROLOGICAL MAGAZINE.

*Monthly price 4d., or 5s. per annum, post-free.*

**THE OLDEST INDEPENDENT METEOROLOGICAL SERIAL,**
**having been established in 1866.**

*CIRCULATES IN ALL PARTS OF THE WORLD.*

Contains early notice of all new Discoveries, Theories, Phenomena, Instruments, and Publications of interest to Meteorologists, Reviews, Correspondence, and details of Climate not only in the British Isles but throughout the Empire.

LONDON:
EDWARD STANFORD, COCKSPUR STREET, S.W.
AND ALL BOOKSELLERS.

---

# HEWITT & SON,

**CHRONOMETER MAKERS**

TO THE

RIGHT HONOURABLE THE LORDS COMMISSIONERS OF THE ADMIRALTY (since 1830).

***344 City* Road, Islington, London, E.C.**

E. DENT & CO.,

**61 STRAND and 4 ROYAL EXCHANGE**
**(Factory: 4 HANWAY PLACE, W.),**
**LONDON.**

MANUFACTURERS OF
ASTRONOMICAL CLOCKS,
GALVANIC CHRONOGRAPHS, WATCHES,
**CHRONOMETERS, SHIPS' COMPASSES,**
TO HER MAJESTY and H.R.H. THE PRINCE OF WALES.

MAKERS OF
**THE GREAT WESTMINSTER CLOCK**
AND OF THE
NEW STANDARD CLOCK
OF
THE ROYAL OBSERVATORY, GREENWICH,
AND OF
**STANDARD CLOCKS AND CHRONOGRAPHS**
FOR THE
**GREENWICH, EDINBURGH, OXFORD, DUNSINK, PULKOWA, BRUSSELS, GENEVA, &c. OBSERVATORIES;**

MANUFACTURERS OF
STANDARD AZIMUTH SHIPS' COMPASSES
AND
MARINE CHRONOMETERS
FOR THE
**BRITISH, AUSTRO-HUNGARIAN, ITALIAN, RUSSIAN, GERMAN, SPANISH, JAPANESE, AND OTHER FOREIGN AND COLONIAL GOVERNMENTS.**

---

CATALOGUES ON APPLICATION.

---

*61 STRAND and 4 ROYAL EXCHANGE,*
LONDON.

UNIVERSITY LIBRARY JUL 22 1895

116

No. 229.] JULY, 1895. [*Price* 1s.

# THE OBSERVATORY,

## A MONTHLY REVIEW OF ASTRONOMY.

EDITED BY
H. H. TURNER, M.A., B.Sc., Sec. R.A.S.,
SAVILIAN PROFESSOR,
T. LEWIS, F.R.A.S.,
H. P. HOLLIS, B.A., F.R.A.S.

## CONTENTS.

PAGE
Meeting of the Royal Astronomical Society on June 14 ..... 255
Meeting of the British Astronomical Association on May 29 ..... 263
Meeting of the Royal Meteorological Society on June 19 ..... 265

**Articles**:—
Variation of Latitude ..... 266
Fireball. By W. F. Denning, F.R.A.S. ..... 270
Selenographical Notes. By T. G. Elger, F.R.A.S. ..... 271

**Correspondence**:—
Naked-eye Views of Mercury. By W. F. Denning, F.R.A.S. ..... 273
Heis's Meteor Radiant T. By W. H. S. Monck, M.A., F.R.A.S. ..... 274
Lamont's Observations of Neptune. By W. T. Lynn, B.A., F.R.A.S. ..... 275

**Observatories**:—
Greenwich.—University of Oxford.—Bidston ..... 276-278

**Publications**:—
Bulletin by the Permanent Committee of the Astrographic Chart, Vol. II. part 5 ..... 279

**Notes**:—
Comet Notes.—Minor Planet Notes.—Observations of Jupiter's Satellites.—δ Equulei.—Comparison of Catalogues.—Dante's Astronomy. Editorial.—From an Oxford Note-book ..... 281-290

**All Communications should be addressed to the EDITORS of the 'Observatory,' Royal Observatory, Greenwich, S.E.**

Annual Subscription (for the "Companion" and twelve Monthly Numbers):—13 *shillings*.

LONDON:
PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET, E.C.

# CONTENTS OF No. 228.

PAGE
Meeting of the Royal Astronomical Society on May 10 .......... 215
Meeting of the British Astronomical Association on April 24 .......... 225
Meeting of the Royal Meteorological Society on May 15 .......... 228

**Articles**:--

Prof. Keeler's Spectroscopic Observations of Saturn. By Prof. J. E. Keeler 227
Algol .......... 229
Selenographical Notes. By T. G. Elger, F.R.A.S. .......... 231

**Correspondence**:--

Meteoric Radiants near γ Pegasi. By W. F. Denning, F.R.A.S. .......... 233
Stellar Chromatics. By Rev. W. R. Waugh, F.R.A.S. .......... 234
The Constitution of Saturn's Rings. By W. T. Lynn, B.A., F.R.A.S. .......... 235

**Observatories**:--

Annual Report of the Paris Observatory.—Rugby.—Hamburg .......... 236-239

**Publications**:--

Mr. Elger's Work on the Moon.—Solar Energy .......... 239-243

**Notes**:--

The Memorial to the late Professor John Couch Adams.—Obituary (M. L. Trouvelot).—η Cassiopeiæ.—Mr. Lowell's Lectures on Mars.—κ Pegasi.—Dante's Astronomy.—The Weather.—Société Belge d'Astronomie.—An Opinion on Universal Time.—Longitude of Madras.—Editorial Notes.—From an Oxford Note-book .......... 244-254

---

**FOR SALE,** by Executors of the late William Binns, Esq., A.M.I.C.E., 5½-inch Equatorial, with Driving-clock, Polarizing eyepiece, Sun diagonal, Star diagonal, eight Eyepieces (viz. Comet, 30, 75, 120, 200, 250, 300, and 400), half-inch finder—all by Cooke of York.

Also 1¾ Transit Instrument, Sidereal Clock, and Observatory. The Observatory has revolving roof and small adjunct for Transit Instrument. Price **£100.** Cost double.

Address: J. ELLIS, Esq., Keynsham, Sandown, I.W.

---

**FOR SALE.**—Astronomical Telescope, with Object-glass of 6-in. aperture and 6-ft. focal length by Grubb, on Equatorial stand, with driving-clock by Cooke of York, R.A. Circle 7 inches, Dec. Circle 10 inches, 7 eyepieces, Barlow lens, combination Sun and Star prism by Cooke.

Apply **C. B.,** care of Editors, Royal Observatory, Greenwich, S.E.

---

**FOR SALE.**—A Sidereal Chronometer in perfect order. Its rate for the last two years can be inspected before purchase. Price **£10 : 0 : 0.**

W. J. REYNOLDS, 61 Fairholt Road, Stamford Hill, N.

---

**FOR SALE.**—A completely mounted Equatorial Telescope, in perfect working order, 8 inches aperture, by Cooke & Sons, with driving-clock, the last telescope of the late Rev. W. R. Dawes. 10 Huyghenian eyepieces, 2 Kellner comet eyepieces, Barlow lens, Dawes's Solar *eyepiece*, Parallel-wire micrometer, Double Solar prism, all formerly *belonging* to the late Mr. Dawes.

Apply GEO. HUNT, 25 Alleyn Park, West Dulwich, S.E.

DIPLOMA OF HONOUR,

Highest Award, Inventions Exhibition, 1885, for Marine Chronometers and High-Class Watches.

**HENRY P. ISAAC,**

**Chronometer Maker to the Admiralty, the Indian, Italian, and Colonial Governments,**

*MAKER OF ALL KINDS OF TRUSTWORTHY WATCHES.*

10 SPENCER STREET, LONDON, E.C.

Eight and Two-day Chronometers, Keyless Pocket Chronometers, Repeaters, Chronographs, Deck Watches, and fine adjusted Levers, Plain and Keyless, kept in Stock.

---

**W. WRAY, Optician,**

MANUFACTURER OF

ASTRONOMICAL AND TERRESTRIAL TELESCOPES,

*EQUATORIAL and other MOUNTINGS, EYEPIECES, &c., &c.,*

MICROSCOPE OBJECTIVES AND MICROSCOPES.

PHOTOGRAPHIC LENSES,

LANTERN PROJECTION LENSES, &c., &c.

ILLUSTRATED CATALOGUE FREE.

LAUREL HOUSE, NORTH HILL, HIGHGATE, LONDON, N.

---

**KENDAL & DENT,**

WATCHMAKERS TO THE ADMIRALTY,

THE ROYAL ITALIAN NAVY, etc.,

106 CHEAPSIDE, LONDON, E.C.

MANUFACTURERS OF

**Marine and Pocket Chronometers, Deck Watches, finely adjusted English Lever Watches, with Kew Observatory Certificates.**

*GOLD MEDAL PARIS INTERNATIONAL EXHIBITION, &c.*

Large Illustrated Catalogue post-free on application.

# JAMES POOLE & CO.,

**CHRONOMETER, CLOCK, & WATCH MANUFACTURERS,**

**Contractors to the Admiralty, The Council of State for India, the Crown Agents for the Colonies, the War Office, the Italian Government, &c.**

**BY SPECIAL APPOINTMENT.**

*Fine Watches and Chronometers Repaired, &c.*

*SPECIALITY:*

**CHRONOGRAPH STOP WATCHES, AS SUPPLIEO TO THE ROYAL NAVY.**

**33 SPENCER STREET, CLERKENWELL, LONDON.**

DIPLOMA AND MEDAL.

**Electrical Exhibition 1892, for non-magnetizable Watches**
(*See* TIMES, March 22, 1894, *and our Book on* WATCHES).

**S. SMITH & SON, 9 Strand, London,**
WATCHMAKERS TO THE ADMIRALTY

**Largest Stock of Kew Certificated Watches in the World**
**in Silver Cases, from £8 10s.**
**Class "A" 8 up to 81·7 marks.**

OUR SUCCESSES AT KEW OBSERVATORY WITH HIGH-CLASS WATCHES.

| Year. | Total Number of Watches sent by all Makers, English & Foreign. | Number of Watches gaining Distinction and Published in the Blue Book & Reports of the Royal Society. | Our Own. |
|---|---|---|---|
| 1888 | 569 | 12 | 2 |
| 1889 | 528 | 19 | 4 |
| 1890 | 513 | 13 | 2 |
| 1891 | 709 | 17 | 2 |
| 1892 | 1044 | 17 | 2 |
| 1893 | 1521 | 18 | 2 |
| 1894 | 737 | 14 | 4 |

AND **THREE** YEARS OUT OF THESE SEVEN WE HAVE HAD THE BEST WATCH OF THE YEAR.

*S. S. & SON'S 'Guide to the Purchase of a Watch' is the most complete one in existence. 144 pages and nearly 300 illustrations.*

**Particulars on application.**

**CALVER'S "COMPLETE EQUATORIAL."**

*(Letters Patent.)*

This New Model embraces many radical and important improvements, making the NEWTONIAN REFLECTOR complete and perfect. Particulars and *Price* lists free.

New edition of "HINTS ON REFLECTORS," &c. &c., illustrated.
By G. CALVER, F.R.A.S., Widford, Chelmsford.

**Pp. xi, 361; Demy 8vo. With 2 Plates and 65 Woodcuts. Price 10s.**

# TELESCOPIC WORK FOR STARLIGHT EVENINGS.

BY

WILLIAM F. DENNING, F.R.A.S.

(Formerly President of the Liverpool Astronomical Society.)

## *EXTRACTS FROM REVIEWS.*

"As might be expected from such an experienced and enthusiastic observer as Mr. Denning, this book is thoroughly practical. He is not contented with describing the beauties of the skies, but gives invaluable information as how to see them best. To observers of limited means the book will be of the greatest assistance, both in the selection and use of their instruments. The book is full of important practical details. Every one who uses a telescope or intends to use one, of whatever dimensions, should read Mr. Denning's book."—*Nature.*

"There is a peculiar interest and fascination connected with the subject of Astronomy, which even the comparatively uneducated reader cannot but feel, and hence there exists here a field for popular presentation which is hardly equalled in any other branch of science. The present work is one of this class, and is fresh in matter, attractive and popular in style, and with its numerous illustrations cannot fail to bring pleasure and instruction to all who use it."—*American Journal of Science.*

Mr. Denning "writes as an observer of skill and experience, whilst the early chapters on the invention, history, and development of the telescope are replete with interest to all, but especially to those who are themselves astronomical observers."—*Athenæum.*

"It deserves to be read with respect and attention by every amateur astronomer; nor can the task prove anything but a pleasure to such as will genially commit themselves to the guidance of an author whose arbitrary dealings, here and there, with language impart a certain raciness to the ready and animated flow of his discourse. The want, moreover, of such an unpretending handbook is, we believe, genuinely felt. Many persons are the possessors of telescopes which they are at a loss how to employ. Intending observers cannot do better, under these circumstances, than place themselves under Mr. Denning's guidance. The book is suitably and sufficiently illustrated, in large measure from the author's original drawings."—*Saturday Review, May* 23.

"Mr. Denning is universally recognized as one of the greatest living authorities on the subject of Meteoric Astronomy. A work from his pen will therefore be read with much interest and expectation by all lovers of the sublime science, and his readers will not be disappointed. This is a very interesting and valuable work, and all telescopists should procure a copy without delay."—*Philosophical Magazine* (J. E. Gore).

"Mr. Denning is so well known as a patient observer of meteors and comets that a work from him on observational astronomy will be looked upon with special interest."—*Knowledge.*

"The illustrations are numerous and well executed and there is a fairly copious index. Mr. Denning's work will we trust have a large circulation, for it thoroughly deserves it. The book would make an admirable addition to the shelves of a lending library."—*Bristol Times and Mirror.*

"Since the appearance of Webb's '*Celestial Objects for Common Telescopes*' I much doubt if any work more useful to the amateur observer (and notably to the beginner) has appeared than '*Telescopic Work for Starlight Evenings.*' One conspicuous merit of Mr. Denning's excellent book lies in the fact that it is obviously written by a man possessing the most thorough personal familiarity with the objects he so lucidly describes."—*"F.R.A.S." in English Mechanic.*

"Mr. Denning has written in a straightforward earnest fashion that must not only make many difficulties clear to his readers but inspire them with something of his own determination and enthusiasm."—*Observatory.*

"A glance at its table of contents will interest any reader of Astronomy who knows anything of the Author's ability as a practical astronomer and a ready writer on general astronomical themes."—*Sidereal Messenger.*

"Would-be purchasers of telescopes are assisted with sound advice, would-be workers with telescopes are supplied with stimulating suggestions."—*Journal of the British Astronomical Association.*

"Mr. Denning is one of the keenest, most unwearying observers in England, and the book is worthy of his reputation."—*Weekly Mail.*

LONDON:

***TAYLOR & FRANCIS***, Red Lion Court Fleet Street.

1891.

## WORKS PUBLISHED BY TAYLOR AND FRANCIS.

**The London, Edinburgh, and Dublin Philosophical Magazine.** Monthly. 2*s*. 6*d*.
**The Annals and Magazine of Natural History.** Monthly. 2*s*. 6*d*.
**The Observatory, Monthly Review of Astronomy.** 1*s*.
**Aelfric Society's Publications.** 15 parts. 37*s*. 6*d*.
**Aëronautics, by Brewer and Alexander.** 6*s*.
**Anderson's Fauna of Mergui Archipelago.** Vol. I. 30*s*., Vol. II. 15*s*.
**Baird's (Major) Manual for Tidal Observations.** 7*s*. 6*d*.
**Belville's Manual för Thermometer.** 1*s*.
**Blakesley's Table of Hyperbolic Sines and Cosines.** 1*s*.
**Chimmo's (Capt.) Natural History of Euplectella aspergillum.** 5*s*.
**Daubeny on Volcanos.** 21*s*.
**Davis's (J. B.) Crania Britannica,** £6 10*s*. **Thesaurus Craniorum,** 20*s*.
**Denning's Telescopic Work for Starlight Evenings.** 10*s*.
**Douse's Introduction to Gothic of Ulfilas.** 10*s*. 6*d*.
**English Poetry in use at Charterhouse School.** 3*s*. 6*d*.
**Examination Papers set by Examining Board of Physicians and Surgeons.** 6*d*.
**Ditto for Diploma in Public Health.** 6*d*.
**Faraday's Experimental Researches in Chemistry and Physics.** 15*s*.
**Fauna of British India.** Edited by W. T. Blanford, F.R.S.
**Mammalia.** 20*s*. **Fishes.** 2 vols. 20*s*. each.
**Birds.** Vol. I. 20*s*. Vol. II. 15*s*. **Reptilia and Batrachia.** 20*s*.
**Moths.** Vol. I. 20*s*. Vol. II. 20*s*. Vol. III. 20*s*.
**Geological Record.** 1874–1884. 8 vols. 50*s*.
**Glaisher's Barometer Tables,** 1*s*. **Diurnal Range Tables,** 1*s*. 6*d*.
**Glaisher's Hygrometrical Tables.** 2*s*. 6*d*.
**Glaisher's Factor Tables for Fourth, Fifth, and Sixth Millions.** 20*s*. each.
**Hopkins's (E.) Geology and Terrestrial Magnetism.** 8vo. Cloth. 10*s*.
**Ditto. Illustrated Introduction to.** 8vo. Cloth. 4*s*.
**Joule's Scientific Papers.** Vol. I. 20*s*. Vol. II. 12*s*.
**Kennedy, C. A few Chapters in Astronomy.** 3*s*. 6*d*.
**Lehfeldt, R. A. A List of chief Memoirs on Physics of Matter.** 2*s*. 6*d*.
**Lewis's (G.) Catalogue of Japanese Coleoptera.** 2*s*. 6*d*.; on one side, 3*s*. 6*d*.
**London Hospital Pathological Catalogue.** 7*s*. 6*d*. nett.
**M'Intosh's Marine Invertebrates and Fishes of St. Andrews.** 21*s*.
**Merington's French Primer,** 2*s*. 6*d*. **English Primer,** 1*s*.
**Merington's French Pronunciation.** 2*s*. 6*d*.
**Merington's Latin First Course, with Key.** 3*s*. 6*d*.
**Pascoe's Classes, Orders, &c. of the Animal Kingdom.** 3*s*. 6*d*.
**Pascoe's List of British Vertebrate Animals.** 4*s*.
**Pascoe's Student's List of British Coleoptera.** 4*s*. 6*d*.
**Phillips's Geology of Yorkshire.** 2 vols. 30*s*.
**Physical Proceedings and Abstracts.** Monthly. 2*s*. 6*d*.
**Physical Memoirs, translated from foreign sources.** Vol. I. Part I. 4*s*., Part II. 7*s*. 6*d*., Part III. 6*s*.
**Reade's Origin of Mountain-Ranges.** 21*s*.
**Royal College of Surgeons Calendar.** 1*s*.
**Catalogue of Specimens illustrating the Osteology of Vertebrate Animals in Museum.** Part 3. **Aves.** 12*s*.
**Catalogue of Teratological Series.** 5*s*.
**Appendices 5, 6, 7, and 8 to the Second Edition of Descriptive Catalogue of the Pathological Specimens in Museum.** 2*s*. each.
**Examination Papers for Diploma of Fellow and Licence in Dental Surgery.** 6*d*.
**Sharp's (Dr. D.) Staphylinidæ of Japan.** 3*s*. 6*d*.
**Taylor's Scientific Memoirs.** Ser. 1. £6 6*s*.; Ser. 2, £1 4*s*.
**Thomson's (Sir W.) Tables for facilitating Sumner's Method at Sea.** 10*s*. 6*d*. **Forms for ditto.** Sun, 1*s*. Stars, 1*s*.
***Univ.* Coll. London Calendar.** 2*s*. 6*d*. **Pathological Catalogue,** Parts 1 to 3. 2*s*. each; Part 4, 1*s*. **Library Catalogue,** 3 Vols. 7*s*. 6*d*.
***Univ.* Coll. Medical and Biological Catalogue.** 2*s*. 6*d*.
***Wheatstone's* (Sir C.) Scientific Papers.** 15*s*.
**Wollaston's Notes on Lepidoptera of St Helena.** 3*s*. 6*d*.

RED LION COURT, FLEET STREET, LONDON, E.C.